

FLIGHT HANDBOOK

PUBLISHED UNDER AUTHORITY OF
THE SECRETARY OF THE AIR FORCE.

USAF SERIES
F-89D
AIRCRAFT



COMMANDERS ARE RESPONSIBLE FOR
BRINGING THIS TECHNICAL PUBLICATION
TO THE ATTENTION OF ALL AIR FORCE
PERSONNEL CLEARED FOR OPERATION OF
AFFECTED AIRCRAFT.

THIS REISSUE REPLACES T.O. 1F-89D-1, DATED 21 MAY 1956, AND SAFETY OF FLIGHT
SUPPLEMENTS -1CK THROUGH -1CN. SEE BASIC INDEX, T.O. 0-1-1, AND WEEKLY INDEX,
T.O. 0-1-1A, FOR CURRENT STATUS OF SAFETY OF FLIGHT SUPPLEMENTS.

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NOTE: The portion of the text affected by the current revision is indicated by a vertical line in the outer margins of the page.

This publication consists of the following pages:

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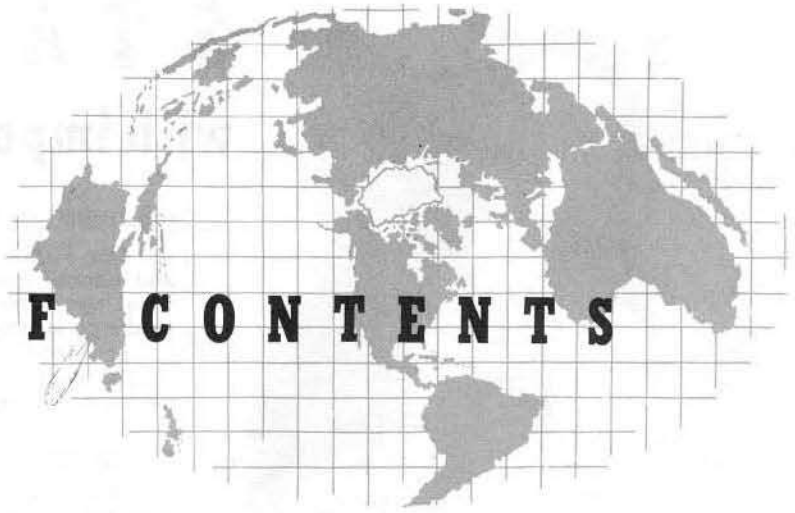


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TO GAIN MAXIMUM BENEFIT FROM THIS
HANDBOOK READ THE FOLLOWING CAREFULLY.

SCOPE

This handbook contains all the information necessary for safe and efficient operation of the F-89D. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the airplane, its flight characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and elementary instructions have been avoided.

SOUND JUDGMENT

The instructions in this handbook are designed to provide for the needs of a crew inexperienced in the operation of this airplane. This book provides the best possible operating instructions under most circumstances, but it is a poor substitute for sound judgment. Multiple emergencies, adverse weather, terrain, etc., may require modification of the procedures contained herein.

STACKED...

with important information

PERMISSIBLE OPERATIONS

The Flight Handbook takes a "positive approach" and normally tells you only what you can do. Any unusual operation or configuration (such as asymmetrical loading) is prohibited unless specifically covered in the Flight Handbook. Clearance must be obtained from ARDC before any questionable operation is attempted which is not specifically covered in the Flight Handbook.

STANDARDIZATION

Once you have learned to use one Flight Handbook, you will know how to use them all — closely guarded standardization assures that the scope and arrangement of all Flight Handbooks are identical.

ARRANGEMENT

The handbook has been divided into ten fairly independent sections each with its own table of contents. The objective of this subdivision is to make it easy both to read the book straight through when it is first received and thereafter to use it as a reference manual. The independence of the sections also makes it possible for the user to rearrange the book to satisfy his personal taste and requirements. The first three sections cover the minimum information required to get the airplane safely into the air and back down again. Before flying any new airplane these three sections must be read thoroughly and fully understood. Section IV covers all equipment not essential to flight but which permits the airplane to perform special functions. Sections V and VI are obvious. Section VII covers lengthy discussions on any technique or theory of operation which may be applicable to the particular airplane in question. The experienced pilot will probably not need to read this section but he should check it for any possible new information. The contents of the remaining sections are fairly obvious.

YOUR RESPONSIBILITY

These Flight Handbooks are constantly maintained current through an extremely active revision program. Frequent conferences with operating personnel and constant review of UR's, accident reports, flight test reports, etc., assure inclusion of the latest data in these handbooks. In this regard, it is essential that you do your part! If you find anything you don't like about the book, let us know right away. We cannot correct an error whose existence is unknown to us.

PERSONAL COPIES, TABS, AND BINDERS

In accordance with the provisions of AFR 5-13, flight crewmembers are entitled to have personal copies of the Flight Handbooks. Flexible, loose leaf tabs and binders

Comments and questions regarding any phase of the Flight Handbook program are invited and should be forwarded through your Command Headquarters to Commander, Detachment #1, Headquarters ARDC, Wright-Patterson AFB, Ohio, Attention: RDZSPH.

have been provided to hold your personal copies of the Flight Handbooks. These good-looking simulated-leather binders will make it much easier for you to revise your handbook as well as to keep it in good shape. These tabs and binders are secured through your local materiel staff and contracting officers.

HOW TO GET COPIES

If you want to be sure of getting your handbooks on time, order them before you need them. Early ordering will assure that enough copies are printed to cover your requirements. Technical Order 0-5-2 explains how to order Flight Handbooks so that you automatically will get all revisions, reissues, and Safety of Flight Supplements. Basically, all you have to do is order the required quantities in the Publication Requirements Table (T.O. 0-3-1). Talk to your Senior Materiel Staff Officer — it is his job to fulfill your Technical Order requests. Make sure to establish some system that will rapidly get the books and Safety of Flight Supplements to the flight crews once they are received on the base.

STATUS OF SAFETY OF FLIGHT SUPPLEMENTS

Safety of Flight Supplements are used to get information to you in a hurry. Safety of Flight Supplements use the same number as your Flight Handbook, except for the addition of a suffix letter. Supplements covering loss of life will get to you in 48 hours; those concerning serious damage to equipment will make it in 10 days. You can determine the status of Safety of Flight Supplements by referring to the Index of Technical Publications (T.O. 0-1-1) and the Weekly Supplemental Index (T.O. 0-1-1A). This is the only way you can determine

whether a supplement has been rescinded. The title page of the Flight Handbook and title block of each Safety of Flight Supplement should also be checked to determine the effect that these publications may have on existing Safety of Flight Supplements. It is critically important that you remain constantly aware of the status of all supplements—you must comply with all existing supplements but there is no point in restricting the operation of your aircraft by complying with a supplement that has been replaced or rescinded. If you have ordered your Flight Handbook on the Publications Requirements Table, you automatically will receive all supplements pertaining to your airplane. Technical Order 0-5-1 covers some additional information regarding these supplements.

WARNINGS, CAUTIONS, AND NOTES

For your information, the following definitions apply to the warnings, cautions, and notes found throughout the handbook:

WARNING

Operating procedures, practices, etc., which will result in personal injury or loss of life if not carefully followed.

CAUTION

Operating procedures, practices, etc., which if not strictly observed will result in damage to equipment.

Note

An operating procedure, condition, etc., which it is essential to emphasize.

U.S. AIR FORCE F-89D-35-NO.
A.F. SERIAL NO. 52-1829

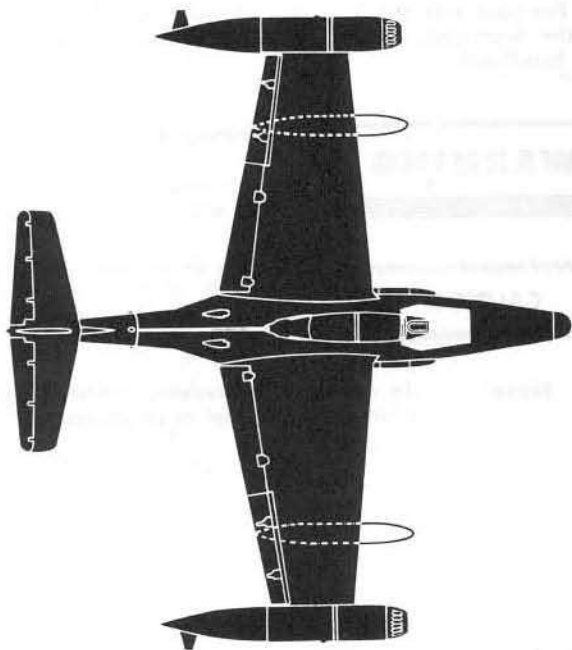
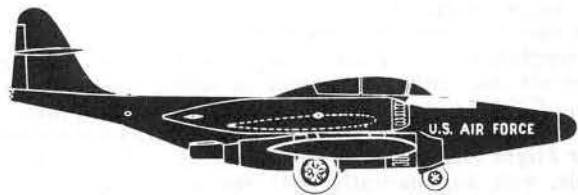
CHECK YOUR GROUP NUMBER...

• GROUP 1	AF51-400	THROUGH	AF51-406
• GROUP 5	AF51-407	THROUGH	AF51-426
• GROUP 10	AF51-427	THROUGH	AF51-446
• GROUP 15	AF51-11298	THROUGH	AF51-11317
• GROUP 20	AF51-11318	THROUGH	AF51-11357
• GROUP 25	AF51-11358	THROUGH	AF51-11407
• GROUP 30	AF51-11408	THROUGH	AF51-11443
• GROUP 35	AF52-1829	THROUGH	AF52-1868

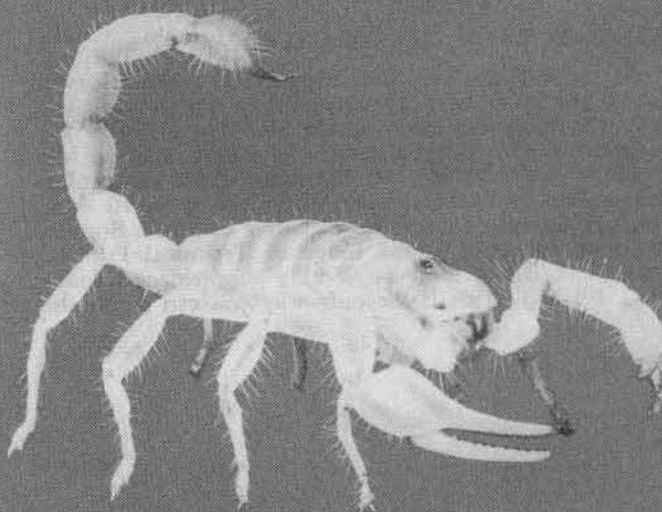
• GROUP 40	AF52-1869	THROUGH	AF52-1910
• GROUP 45	AF52-1911	THROUGH	AF52-1961
	AF52-2127	THROUGH	AF52-2165
• GROUP 50	AF53-2447	THROUGH	AF53-2461
• GROUP 55	AF53-2462	THROUGH	AF53-2521
• GROUP 60	AF53-2522	THROUGH	AF53-2581
• GROUP 65	AF53-2582	THROUGH	AF53-2641
• GROUP 70	AF53-2642	THROUGH	AF53-2686
• GROUP 75	AF54-184	THROUGH	AF54-260

GROUP CODING

AIRPLANES HAVING DIFFERENT, OR ADDITIONAL SYSTEMS AND EQUIPMENT, HAVE BEEN GROUP CODED TO AVOID LISTING AIRPLANE SERIAL NUMBERS.



F-89D SCORPION



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Figure 1-1.



DESCRIPTION

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THE AIRPLANE.

The Northrop F-89D airplane is a two-place, midwing, jet-propelled, all-weather fighter interceptor designed to operate at high speeds and high altitudes. The airplane's function is to locate, intercept, and destroy enemy aircraft by day or night, under all conditions of weather. The crew consists of a pilot and a radar observer. For maximum efficiency, the radar equipment is operated by the observer, thus allowing the pilot to devote his full attention to flying. This division of duties results in higher combat effectiveness. The pilot

and radar observer have individual cockpits with ejection seats, automatic heating, and pressurizing facilities. The tandem cockpits are enclosed by a single jet-tisonable canopy. The airplane is powered by two turbojet engines with afterburner systems. The flight control surfaces are fully powered by two independent hydraulic systems. "Feel," which would otherwise be absent in a powered control system, is supplied artificially to the control stick and to the rudder pedals by springs. Additional elevator "feel" is supplied by a control force bellows system and a "G" operated bobweight. Another unusual feature not found on other

combat airplanes is the combination of ailerons and speed brakes. Each aileron is composed of a leading edge section and two movable aft surfaces, one above the other, hinged at their forward edges. These two surfaces can be opened to any desired angle, up to an included angle of 120 degrees, to function as a speed brake. The left and right speed brakes operate simultaneously. Pylons under the wings can carry jettisonable fuel tanks.

AIRPLANE DIMENSIONS.

Refer to figure 1-2 for dimensions of this airplane.

AIRPLANE GROSS WEIGHTS.

The design gross weight is approximately 38,000 pounds while the maximum gross weight is approximately 46,000 pounds (see figure 5-4). Detailed information on weight limitations will be found in Section V.

ARMAMENT.

Standard armament consists of tip pod rockets. For detailed information on armament, refer to Section IV.

ENGINES.

Groups 1 through 20 airplanes are powered by two J35-47 axial-flow turbojet engines. Group 25 and subsequent airplanes are powered with two J35-35 turbojet engines. Both the -47 and -35 engines are equipped with afterburners and retractable air inlet screens. On the front of each engine are mounted all accessories driven by the engine shaft, including engine fuel pump, oil pump, engine fuel control, hydraulic pump, starter-generator, and tachometer generator. Air enters through the engine air scoop and is progressively compressed through 11 stages in the axial-flow compressor. A portion of the 11th stage compressor air is used to pressurize the pylon and wing tip fuel tanks and to operate the thermal anti-icing system, the afterburner fuel pump, the air-conditioning system, the canopy seal, and the anti "G" suit. The main flow of air from the compressor then enters the eight combustion chambers where fuel is sprayed under pressure and combustion occurs. The hot combustion gases rotate a turbine wheel which drives the compressor, both turbine wheel and compressor being mounted on the same shaft. From the turbine wheel, the gases travel through the exhaust cone and into the afterburner where additional fuel may be injected and burned if more thrust is desired. The gases are then discharged from the tailpipe. (See figure 1-5.) On Groups 1 through 20 airplanes, the afterburner tailpipe nozzle is equipped with eyelids which are closed during all phases of nonafterburner operation (minimum eyelid opening). During afterburning, the eyelids open automatically to increase tailpipe diameter, thus allowing additional thrust without excessive exhaust gas temperatures. On Group 25 and subsequent airplanes, the

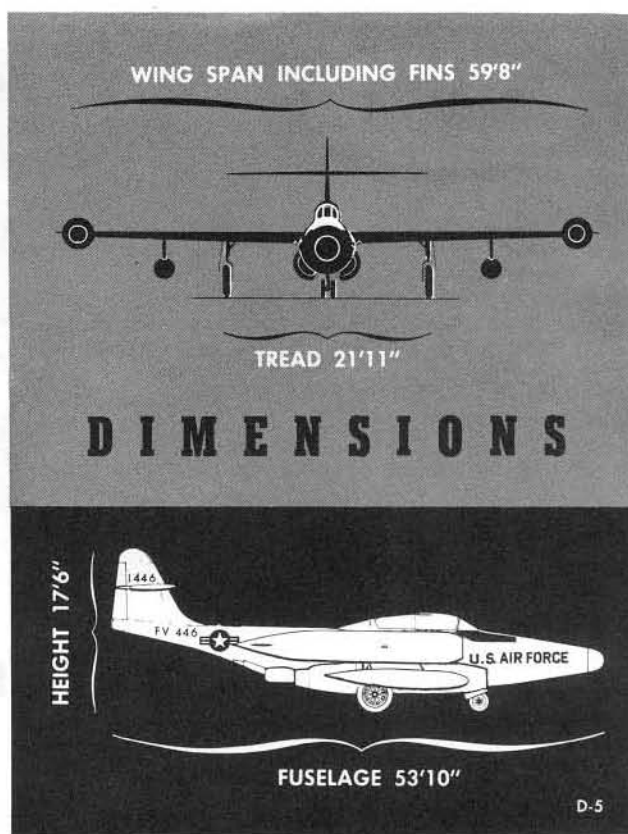


Figure 1-2.

afterburner eyelids, in addition to opening during afterburning, will stay open during starting to prevent high temperatures, and during rapid acceleration (below 10,000 feet) to decrease acceleration time. Each engine at 100% rpm has a rated thrust of 5600 pounds without afterburning and 7400 pounds with afterburning. For a detailed discussion of the eyelids, see Eyelid Operation, Section VII.

ENGINE FUEL CONTROL SYSTEM.

Each engine has one gear-type, constant displacement, engine-driven fuel pump and one fuel control installed in the accessory section. The maximum output of each fuel pump is 26 gallons per minute. On Group 25 and subsequent airplanes, the engine-driven fuel pump incorporates two pumping elements. Should one element fail, the other element will maintain the required fuel pressure. The fuel control automatically maintains the quantity of fuel supplied to the engine within a range that will prevent "rich blow-out" during engine acceleration and "lean die-out" during deceleration, and bypasses any fuel in excess of that required by throttle setting, engine speed, and altitude. For engine starting and controlled acceleration during starting, the fuel is supplied to the combustion chambers in a wide-angle spray for ignition. This spray narrows its angle to distribute the combustion more evenly throughout the chamber as the engine accelerates. The change in

spray characteristics is controlled within the nozzle by a spring-loaded valve which opens another set of orifices in the nozzle jet as fuel pressure builds up in the nozzle. The fuel control also prevents the engine from overspeeding for a given throttle setting, and maintains a constant engine speed regardless of changes in temperature and altitude. A centrifugal governor in the fuel control varies the flow of fuel to the nozzles according to engine speed and throttle position. (See figure 1-6.) Refer to Section VII for additional information on engine operation.

Throttles.

Each of the two throttles (figure 1-7) on the pilot's left console mechanically regulates an engine fuel control. Markings on the throttle quadrant are CLOSED and OPEN. Mechanical stops at the IDLE position prevent retarding the throttle below the idle speed of the engines (40% to 42.5% rpm on J35-47; 49% to 51% rpm on J35-35). The throttles can be retarded past the idle stops by raising the fingerlifts under the throttle knobs. This allows the throttles to be placed at CLOSED, shutting off fuel flow to the engines at the engine fuel control. On Group 75 airplanes a throttle-actuated switch closes a shutoff valve in the fuel line from the main tank when the throttle is moved to CLOSED. Each throttle fingerlift connects to an afterburner demand switch that will start afterburning on the corresponding engine when the throttle is between the 90% and 100% rpm range. Afterburning is stopped by retarding the throttle below the 90% position, or by depressing the fingerlift when the throttle is in the 90% to 100% rpm range. The right throttle knob houses a press-to-talk microphone button.

Throttle Friction Lever.

A throttle friction lever (figure 1-7) is provided on the throttle quadrant outboard of the throttles. When the lever is moved toward INCREASE or DECREASE, resistance to throttle movement will increase or decrease accordingly.

ENGINE COOLING AND AIR INDUCTION SYSTEM.

Engine cooling and induction air enters through an air intake at the front of each engine. On the ground and during takeoff, additional induction air is drawn through four intake doors on the outboard side of the engine forward door, and then through a door on the engine transition duct. The combustion sections of the engine compartment and the tailpipe are cooled by ram air supplied through an air scoop on the lower forward section of the engine's No. 3 and No. 4 doors. Retractable screens in the engine air intakes normally extend and retract with the landing gear, but under certain conditions they can be operated during flight. For additional information on engine screens, see Section IV. On Group 10 and subsequent airplanes, vortex generators, in the form of two small air-directing vanes, are installed approximately 40 inches forward of each engine air intake duct. The effect of these vanes is to

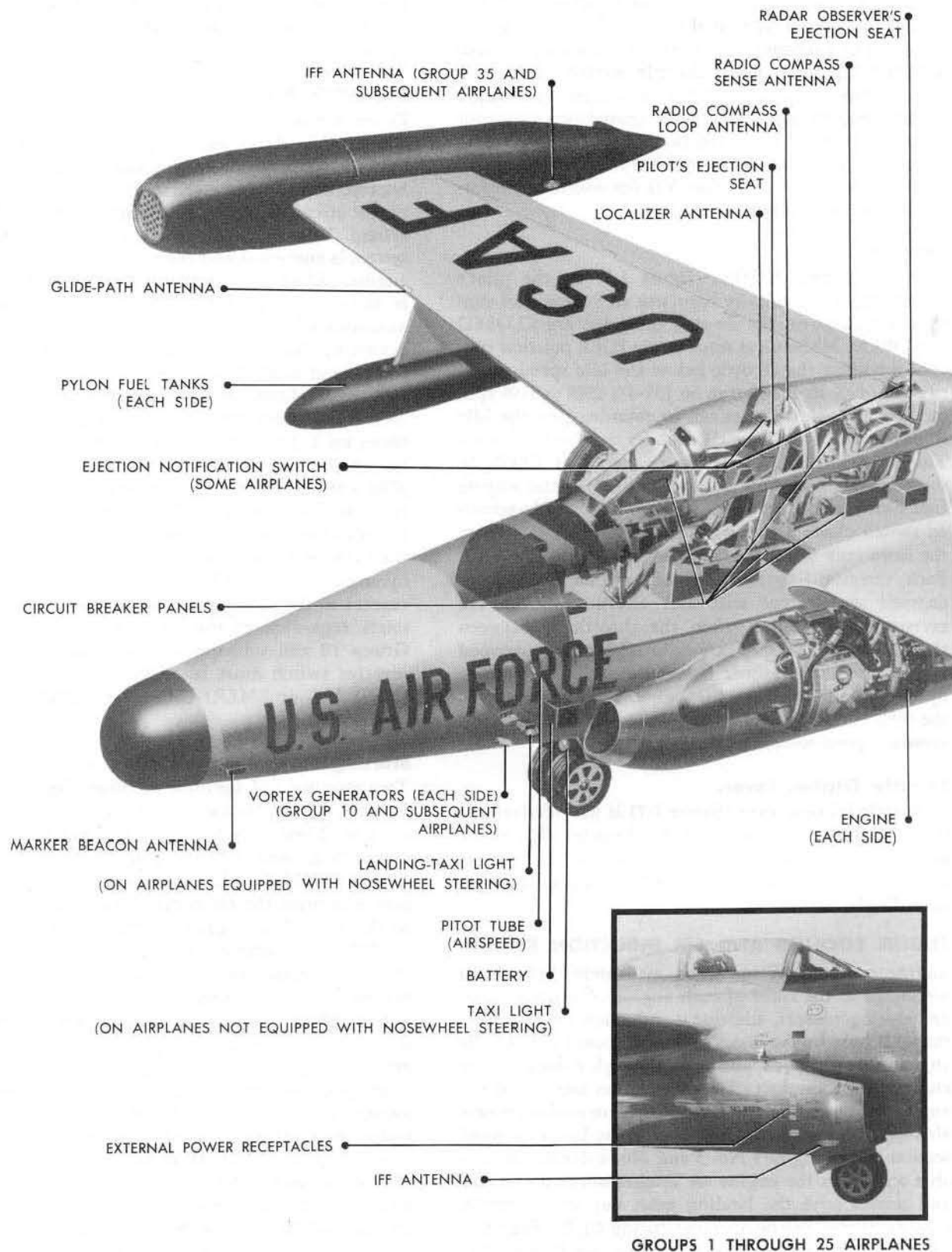
prevent the intermittent separation of airflow through the engine transition duct and the resultant noise and vibration which would occur at high airspeed and low rpm.

STARTING AND IGNITION SYSTEM.

Power for starting is supplied by external power units connected to the power receptacles on the right air intake duct. Only one engine can be started at a time, because actuating one starter-generator breaks the d-c power circuit to the other engine's starter and ignition system. When a starter switch is actuated, the ignition system is energized and the starter-generator cranks the engine. After the throttle is opened and combustion is self-sustaining, the starting and ignition circuits automatically disconnect when the electrical load drawn by the starter-generator drops to 200 amperes; this should occur at an engine speed of approximately 26% rpm. Then the starter-generator functions as a 28-volt d-c generator. The engine ignition system operates on 115-volt a-c power. The primary (essential) bus of the single-phase (power) inverter system supplies current to the ignition transformers which, in turn, send extremely high voltage to the two igniter plugs in each engine for both ground and air starting. On Groups 1 and 5 airplanes, the spare single-phase inverter is turned on by the starter switch and supplies current to the primary bus for ignition during ground starts, regardless of the inverter switch position. On Group 10 and subsequent airplanes, the single-phase inverter switch must be placed at MAIN or SPARE (NORMAL or EMER) before a-c current is available for starting.

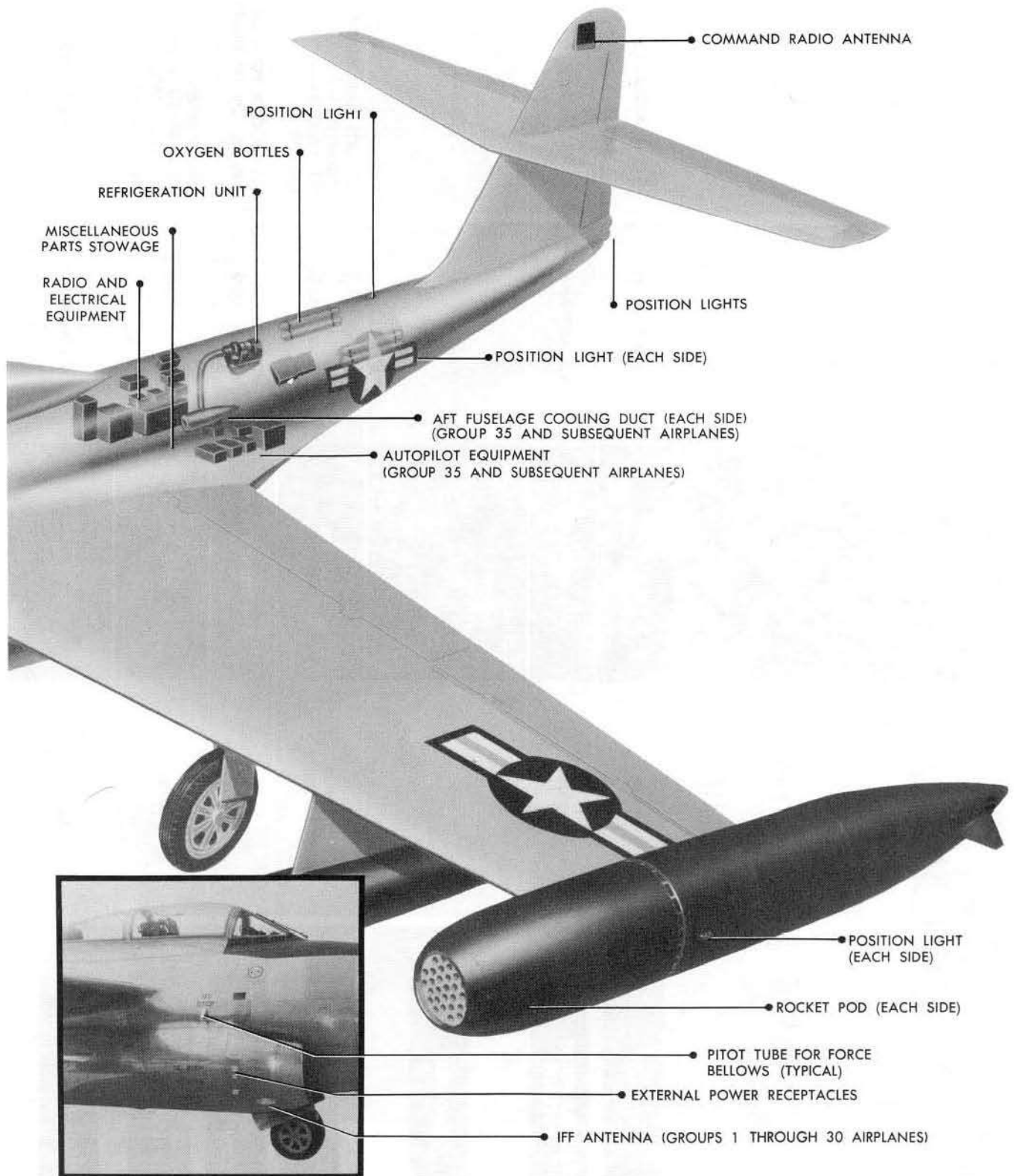
Starting and Ignition Switches.

Two starting and ignition switches (figure 1-12), one for each engine, are located on the pilot's right vertical console. These switches have three positions; START, NEUTRAL, and STOP. The switches are spring-loaded to NEUTRAL. The switches, using 28-volt d-c power, control the electrical circuits to the starter and to the 115-volt a-c ignition system. When a switch is at NEUTRAL, starting and ignition circuits are open. Placing a starter switch momentarily at START energizes the starter and completes the circuit to the igniter plugs. When the load drawn by the starter drops to 200 amperes, the starting and ignition circuits automatically disconnect; this should occur at an engine speed of approximately 26% rpm. Placing the switch momentarily at STOP will deenergize the starter and ignition circuits. Group 75 airplanes in compliance with T.O. 1F-89-611 are modified to interlock the starter control circuit with the fuel selector switches, making it impossible to start an engine with its fuel selector in the PUMPS OFF position. This modification prevents loss of afterburner power during takeoff; however, this modification will have no effect on loss of afterburner power due to system malfunction or PUMPS OFF fuel selector switch settings made after starting engines.



GENERAL

Figure 1-3.



GROUP 30 AND SUBSEQUENT AIRPLANES

ARRANGEMENT

MAIN DIFFERENCES TABLE		F-89B AND C		F-89D		F-89H		F-89J	
ITEM									
EXTERNAL POWER RECEPTACLES		THREE: Groups 1, 5, and 16 B airplanes FOUR: Group 15 B airplanes and all C airplanes		FOUR: Groups 1 through 25 airplanes THREE: Group 30 and subsequent airplanes		THREE		THREE	
AUTOPILOT		NONE		Group 35 and subsequent airplanes		ALL AIRPLANES		ALL AIRPLANES	
SINGLE-POINT FUELING		NONE		ALL AIRPLANES		ALL AIRPLANES		ALL AIRPLANES	
ENGINES		J35-47		J35-47: Groups 1 through 20 airplanes J35-35: Group 25 and subsequent airplanes		J35-35		J35-35	
ARMAMENT		SIX 20MM NOSE GUNS		ROCKETS		ROCKETS AND MISSILES		ROCKETS AND PYLON MOUNTED SPECIAL WEAPONS AND MISSILES	
WING TIP CONFIGURATION		FUEL TANKS		FUEL-ROCKET PODS		FUEL-ROCKET MISSILE PODS		FUEL-ROCKET PODS OR 800-GALLON TIP TANKS	
PYLON TANKS		NONE		ALL AIRPLANES		ALL AIRPLANES		TANKS INTER- CHANGEABLE WITH SPECIAL WEAPONS— ALL AIRPLANES	
NOSE FUEL TANK		NONE		ALL AIRPLANES		ALL AIRPLANES		ALL AIRPLANES	

Figure 1-4.

Altitude Start and Starter Test Switches.

Two altitude start and starter test switches (figure 1-18), one for each engine, are located on the aft miscellaneous control panel above the pilot's left console. These switches are used for supplying ignition during air starts and for turning the engine over with the starter without ignition. The switches have three positions: TEST, NEUTRAL, and START; and they are spring-loaded to NEUTRAL. The switches, using 28-volt d-c power, control separate electrical circuits to the 115-volt a-c ignition system and the 28-volt d-c starter. When a switch is at NEUTRAL, starting and ignition circuits are open. When an air start is required, placing the switch momentarily at START will supply ignition to the windmilling engine for 120 seconds through a time-delay unit. When the switch is held at TEST (for ground operation only), the starter will turn the engine over without ignition.

Emergency-Normal Starting Power Switch.

An unguarded emergency starting power switch (figure 1-12) with ON and OFF positions on Groups 1 through 25 airplanes, or a guarded switch with EMER and NORMAL positions on Group 30 and subsequent airplanes, is located on the pilot's right vertical console. This switch connects the 28-volt d-c primary bus to the starter bus for emergency starting when limited external power is available. When only one 28-volt d-c external power source is available (of at least 1000-amp rating), the one lead may be plugged into the lower d-c receptacle (with the battery switch at OFF) and the starting power switch placed at ON (or

EMER). The engine then can be started with the starter switches. When the starting power switch is at OFF (or NORMAL), the starter bus is disconnected from the 28-volt d-c primary bus.

CAUTION

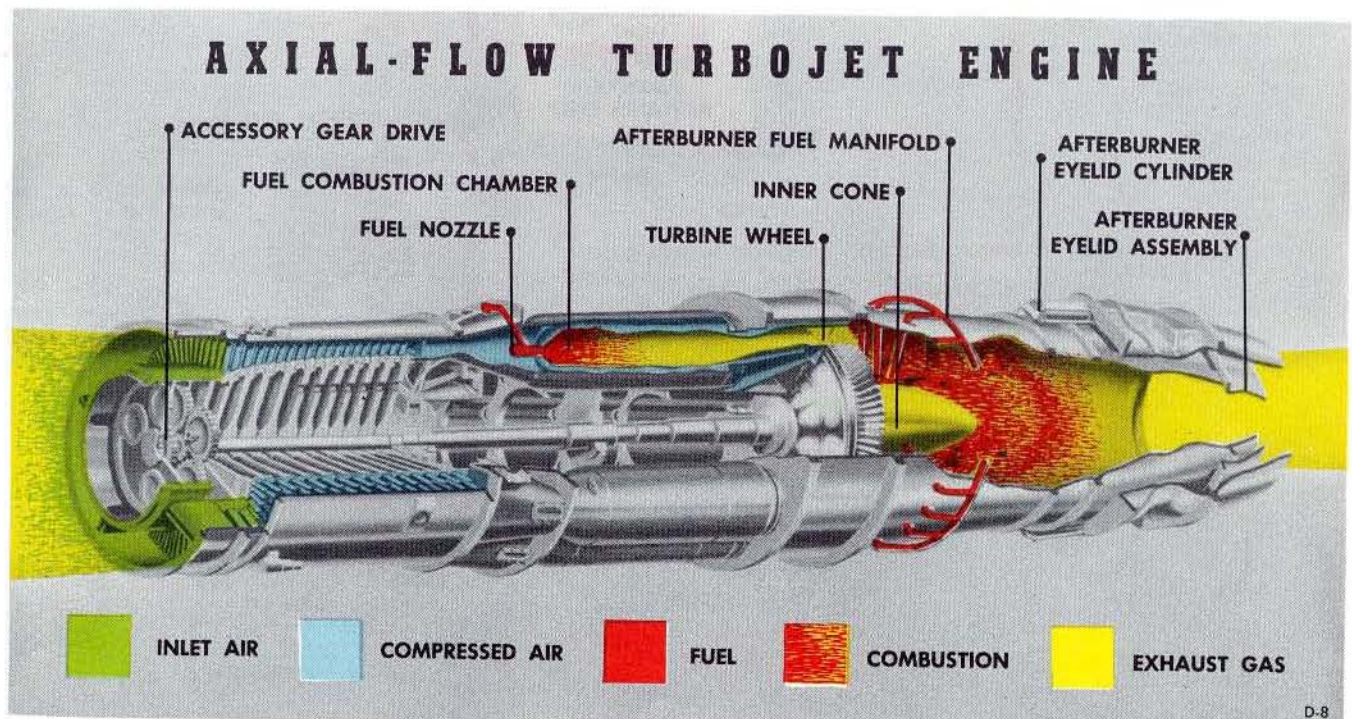
For emergency starts, the 28-volt d-c generator switches must be at OFF. This is to prevent the left generator from overloading during the right engine start.

Note

This airplane cannot be started on the battery. External power is required.

EXHAUST GAS TEMPERATURE GAGES.

Two exhaust gas temperature gages (figure 1-8) indicating exhaust temperatures in degrees centigrade, are located on the pilot's instrument panel. The gages operate from thermocouples located in each engine exhaust cone. When the dissimilar metals of the thermocouple in the exhaust cone are heated, an electromotive force (independent of the airplane's electrical system) is created and gives a reading on the gages. The pilot has no direct control for regulating the exhaust gas temperatures; however, limited control for these temperatures can be indirectly achieved by changing the throttle settings.



D-8

Figure 1-5.

ENGINE FUEL CONTROL SYSTEM

LEFT ENGINE—(Typical)

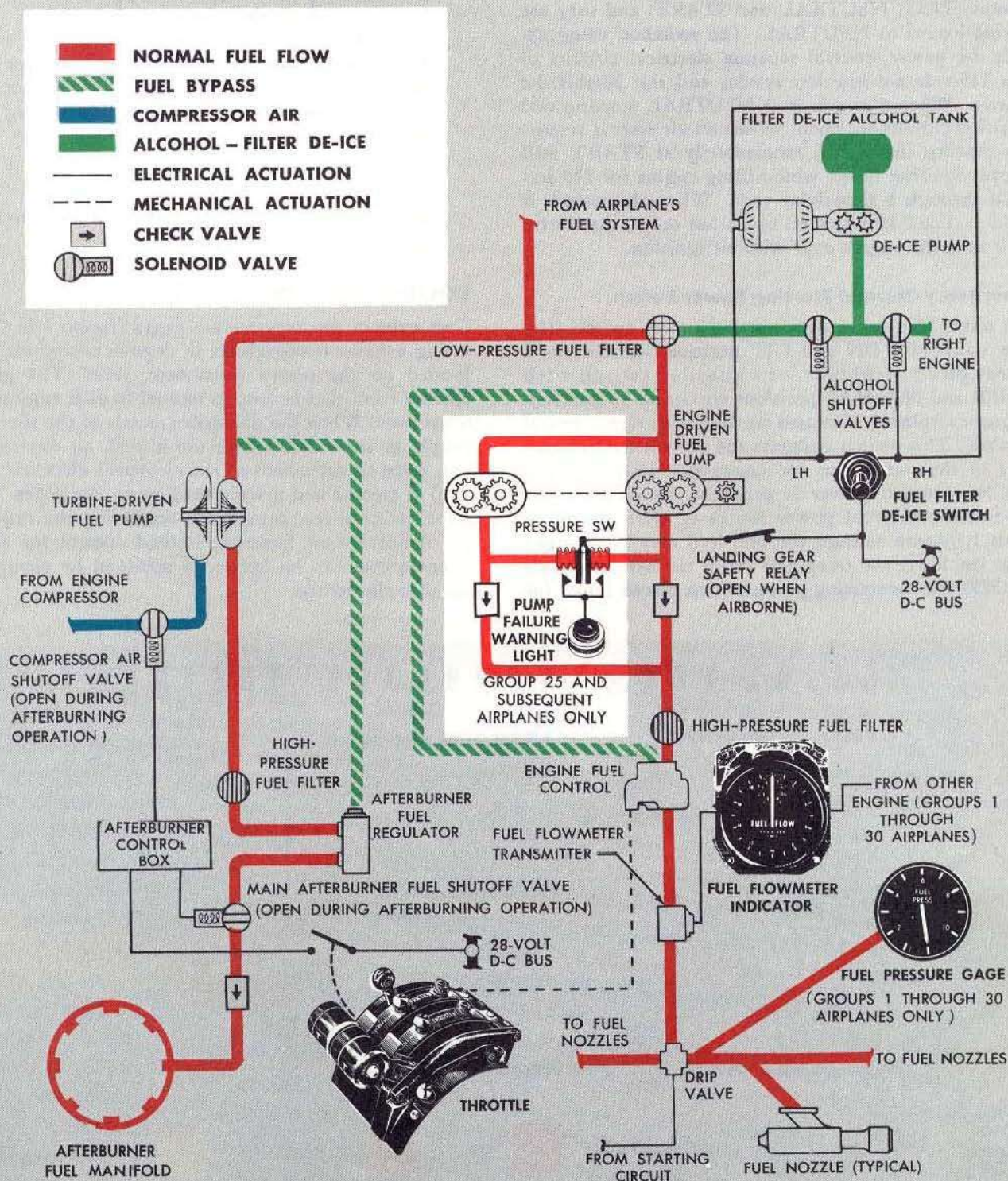


Figure 1-6.

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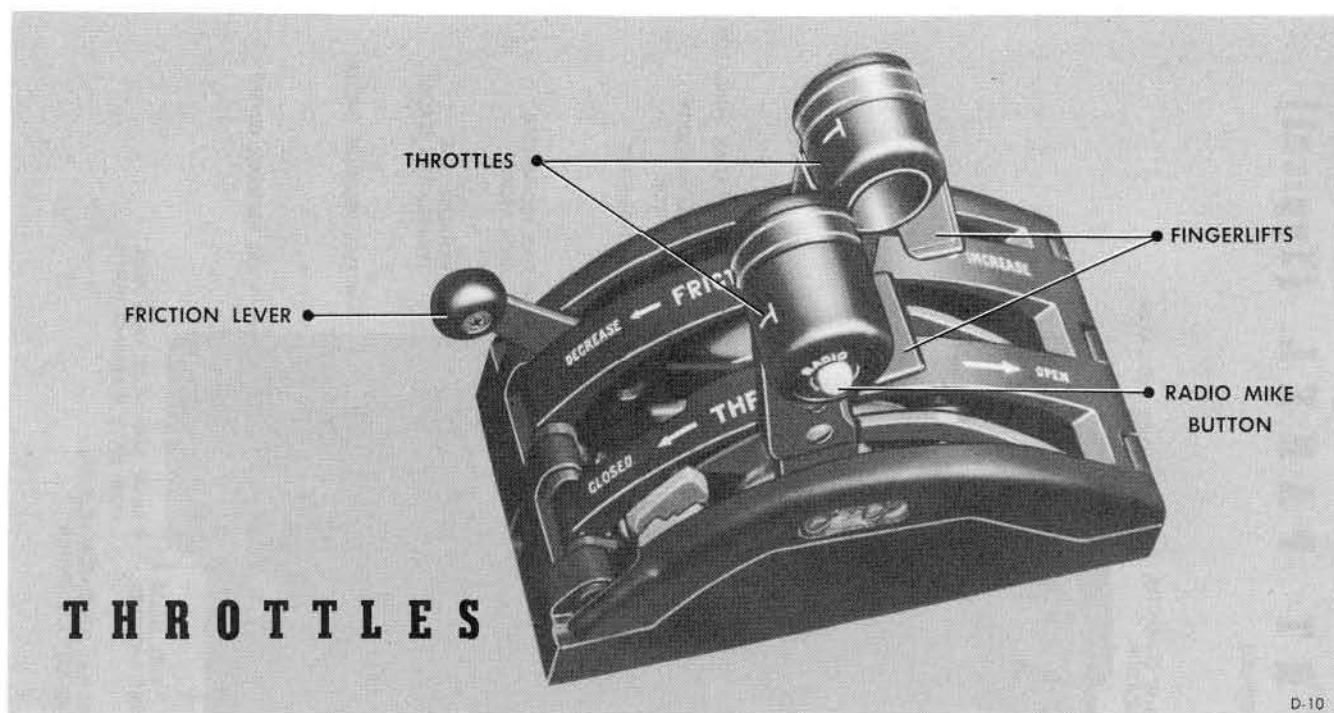


Figure 1-7.

TACHOMETERS.

Two tachometers (figure 1-8), indicating engine speed in percent of maximum rpm, are located on the pilot's instrument panel. A tachometer generator is installed on the accessory section of each engine. The electrical power it produces for tachometer readings is proportional to engine rpm. On this airplane, 100% engine speed is 8000 rpm.

OIL PRESSURE GAGES.

Two oil pressure gages (figure 1-8), one for each engine, are located on the pilot's instrument panel and indicate oil pressure in pounds per square inch. The gages are operated by 115-volt ac from either the main or single-phase inverter system.

FUEL FLOWMETER INDICATORS.

The fuel flowmeter indicators (figure 1-8) register the rate that fuel (any grade or weight) is being consumed by the engines (exclusive of afterburners) in pounds per hour. Groups 1 through 30 airplanes are provided with a single indicator located on the pilot's instrument panel; this indicator shows the rate of fuel consumption for both engines. Group 35 and subsequent airplanes are provided with two indicators (figure 1-8), one for each engine. These indicators are located on the pilot's instrument panel in the space formerly occupied by the fuel pressure gages. The fuel flowmeter system depends on 28-volt dc and 115-volt single-phase ac for operation.

Note

The fuel flowmeter indicators do not indicate fuel consumed by the afterburners.

CAUTION

On Groups 1 through 30 airplanes, the fuel flowmeter indicator is inaccurate for high rates of fuel flow. However, in the cruising range (3000 to 5000 pounds per hour) the indicator may be relied upon for cruise control.

FUEL PRESSURE GAGES (GROUPS 1 THROUGH 30 AIRPLANES).

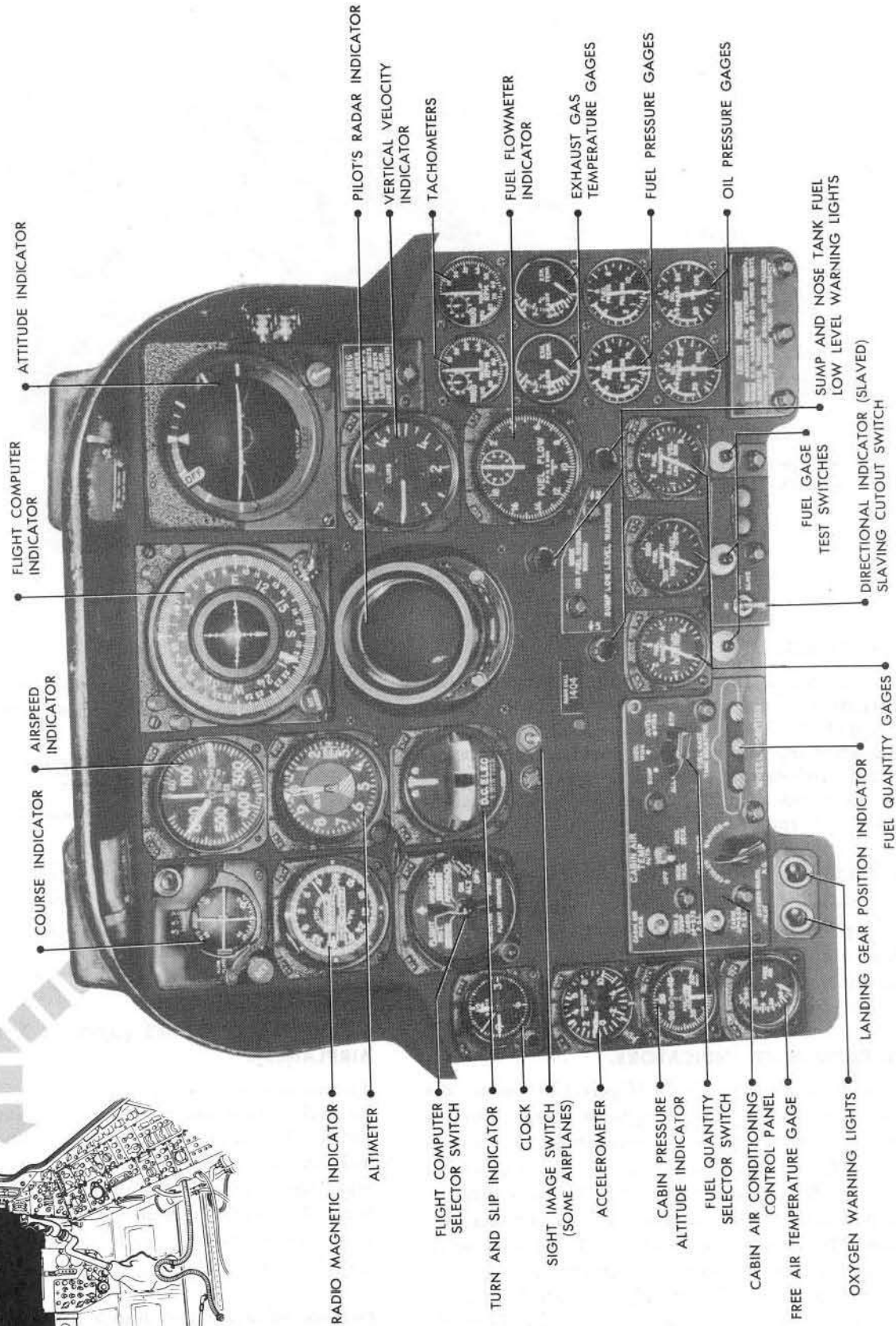
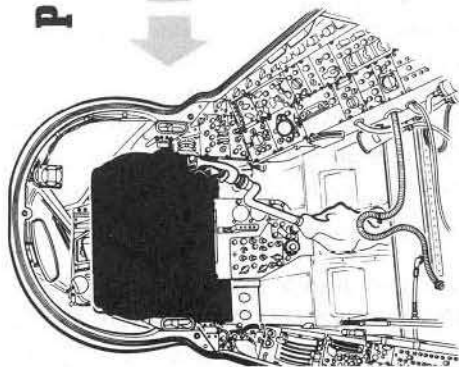
Two autosyn-type fuel pressure gages (figure 1-8), one for each engine, are located on the pilot's instrument panel. The gages, calibrated in pounds per square inch, indicate fuel pressure at the engine fuel manifold. The gages operate on 115-volt single-phase ac. No fuel pressure gages are provided on Group 35 and subsequent airplanes, as each engine is provided with a fuel flowmeter indicator.

ENGINE-DRIVEN FUEL PUMP FAILURE WARNING LIGHTS (GROUP 25 AND SUBSEQUENT AIRPLANES).

Two 28-volt d-c warning lights (figure 1-9), one for each engine, are mounted on a bracket extending from

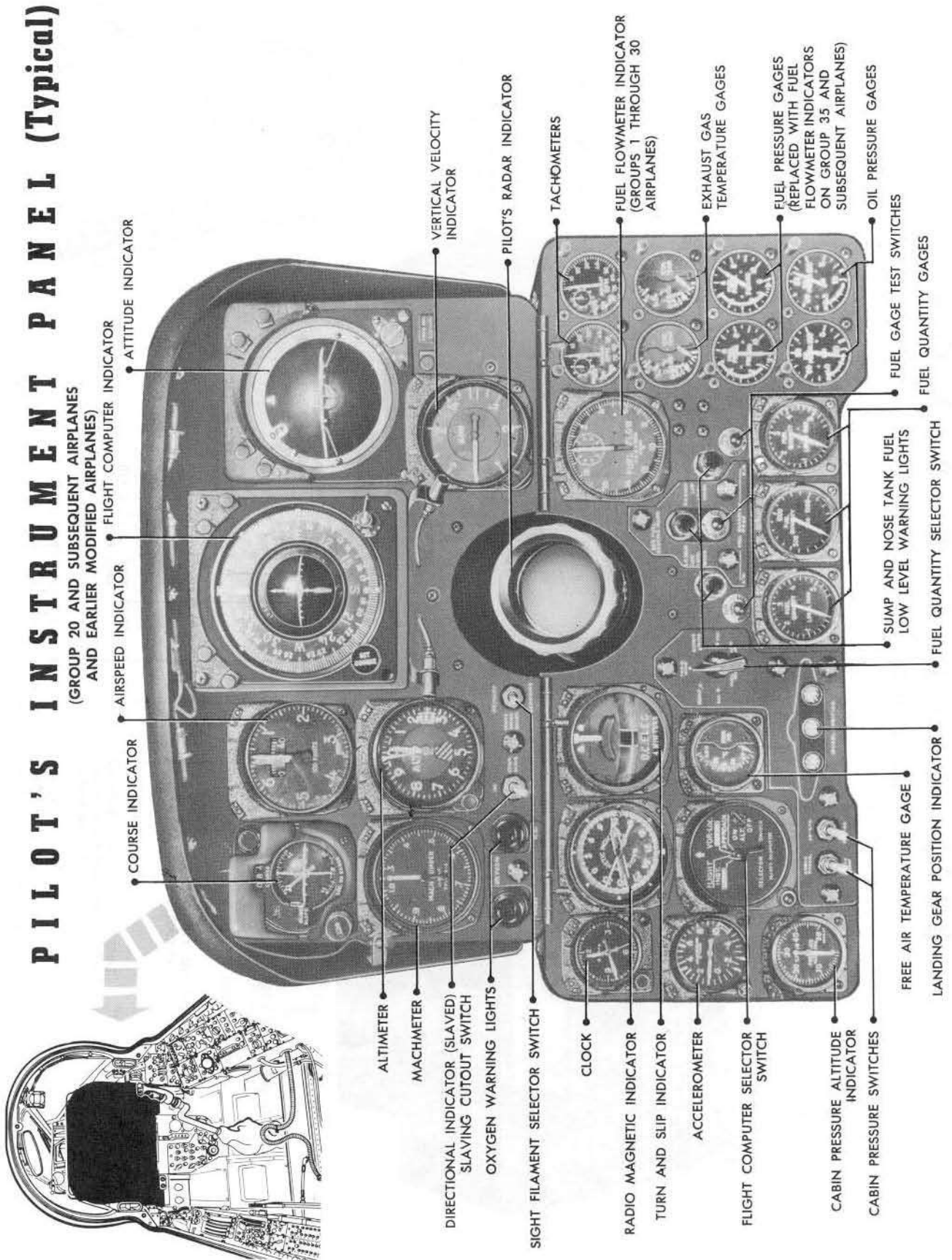
PILOT'S INSTRUMENT PANEL (Typical)

(GROUPS 1 THROUGH 15 AIRPLANES, UNMODIFIED)



D-11(1)

Figure 1-8.



PILOT'S LEFT CONSOLE (Typical)

(GROUPS 1 THROUGH 30 AIRPLANES)

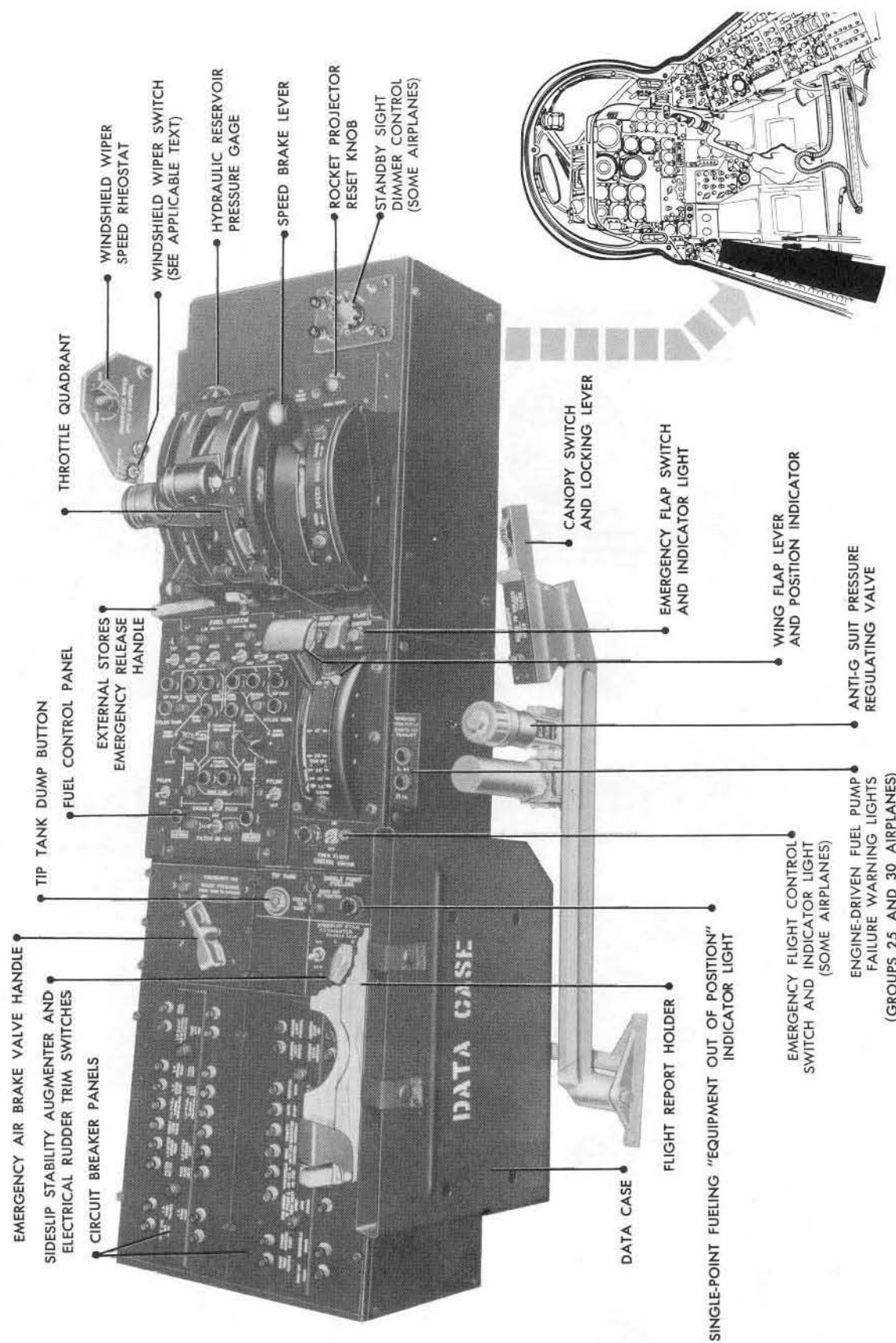


Figure 1-9 (Sheet 1 of 3 Sheets).

PILOT'S LEFT CONSOLE (Typical)

(GROUPS 35 THROUGH 70 AIRPLANES)

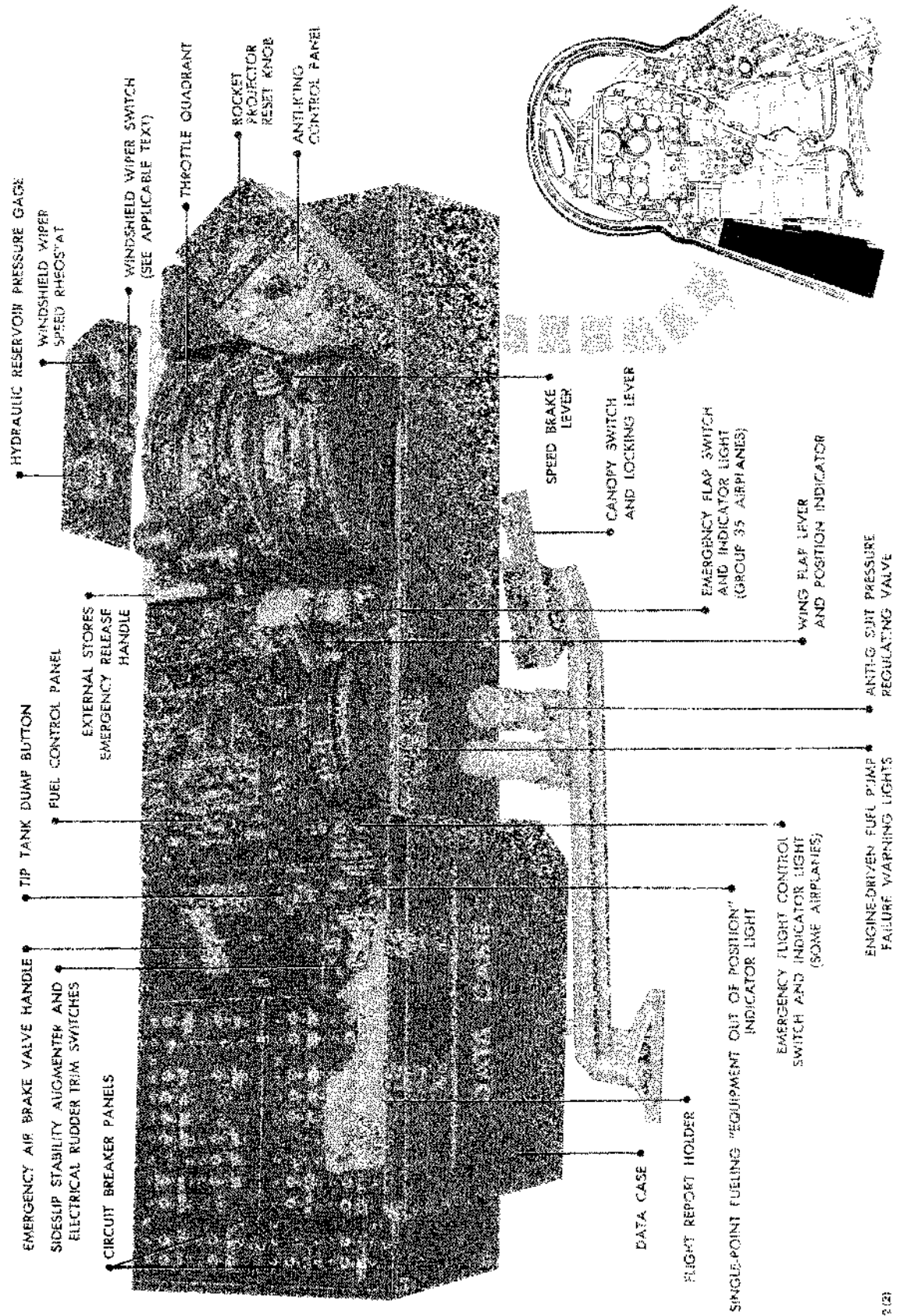


Figure 1-9 (Sheet 2 of 3 Sheets).

P I L O T ' S L E F T C O N S O L E (Typical)

(GROUPS 35 THROUGH 70 AIRPLANES)

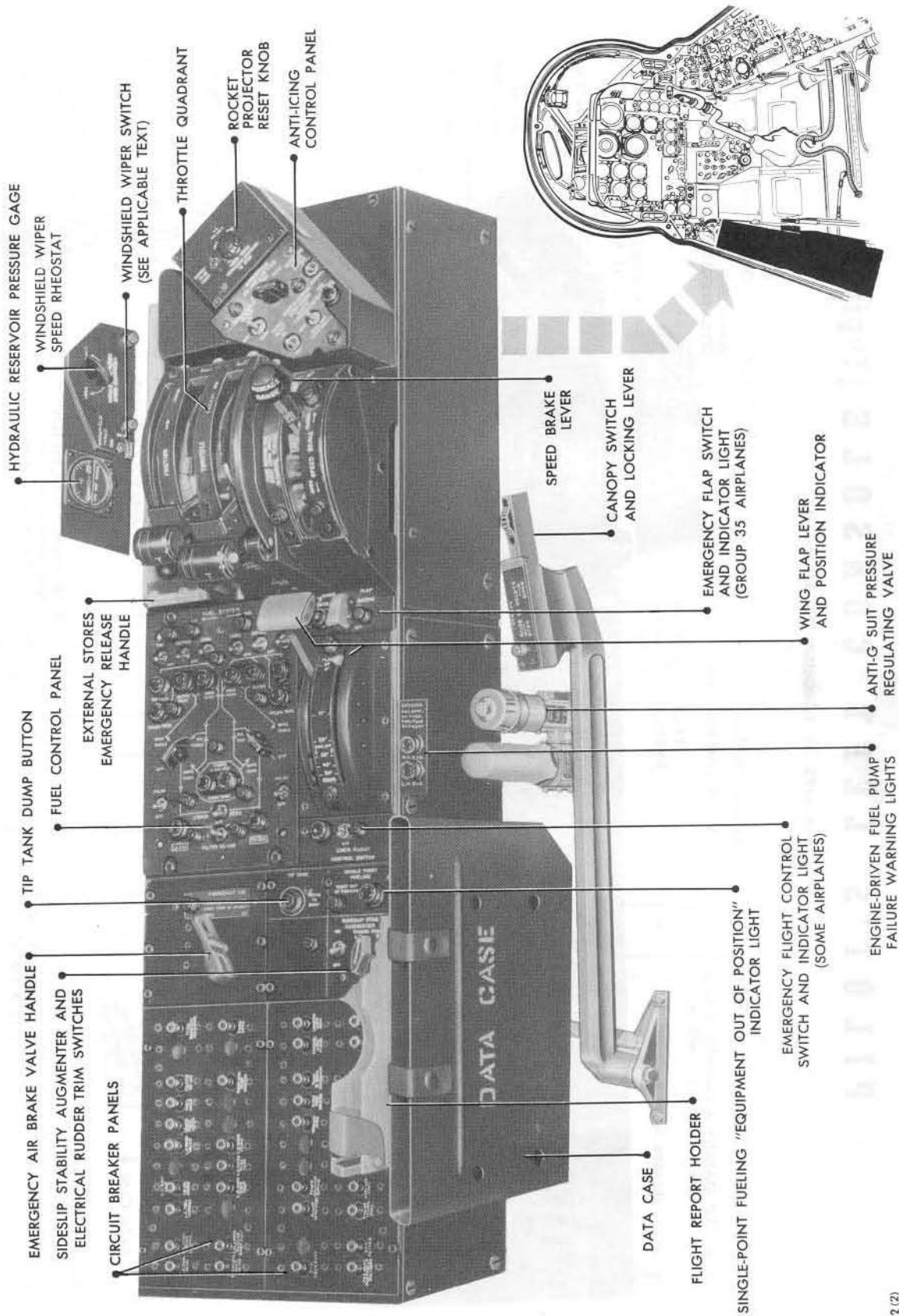


Figure 1-9 (Sheet 3 of 3 Sheets).

the pilot's left console. The lights are provided to warn the pilot that one or both of the two elements of each engine-driven fuel pump are inoperative. The lights are controlled by a pressure switch connected to the two pumping elements. If the fuel pressure drops at the outlet of one or both elements, the switch closes and turns on the light. Lights are for ground check only, as they will not operate when airborne. A switch on the left main landing gear prevents operation when the weight of the airplane is removed from the landing gear.

AFTERBURNER SYSTEM.

Each engine has an afterburner which can be used to increase thrust when needed. The afterburner is a part of the tailpipe. As the gases travel through the exhaust cone and into the afterburner section, more fuel can be injected and burned if additional thrust is desired.

Note

Normal fuel sequencing must be used on Groups 1 through 70 airplanes to maintain afterburning. For further explanation refer to Section VII.

Afterburning is best initiated from a stabilized full-throttle condition. A speed-sensing switch prevents afterburner ignition when engine speed is below 87.5% rpm. The afterburner fuel control system (figure 1-6) consists of a centrifugal-type fuel pump which is driven by an air turbine powered by air bled from the engine compressor. This pump supplies fuel to an afterburner fuel regulator. The fuel regulator, controlled by the difference in pressure between the inlet and the outlet of the engine compressor, automatically meters a continuous flow of fuel to the afterburner. When afterburning is initiated (by lifting the fingerlifts on the throttles), the following operations take place in the automatic control system within approximately 1 second: the afterburner booster pump in the sump tank (Groups 1 through 70 airplanes) starts operating; the afterburner differential pressure switch closes, causing the valve supplying compressor air to the afterburner fuel pump to open; the afterburner fuel shutoff valve opens; and fuel is then supplied through the afterburner shutoff valve to the main afterburner ignition nozzles and into the exhaust gases, causing afterburner ignition. When afterburner fuel ignites, the eyelids open and the afterburner ignition shutoff valve closes, and afterburning continues. Initial afterburner combustion is normally accompanied by a momentary drop in engine speed and a momentary rise in exhaust gas temperature. Afterburning should be completely stabilized in 3 to 4 seconds. When the afterburner is shut off, normal engine operation should stabilize in about the same time. If an afterburner flames out, all units of the system are returned automatically to the nonafterburning condition, and afterburning cannot be reinitiated until the fingerlift is depressed and then

raised again. Exhaust gas temperature with afterburning should stabilize at the same temperature as with military power.

WARNING

Failure of both single phase inverters will render the afterburner and afterburner control circuits inoperative. When this occurs, the throttle-actuated eyelid switches will cause the eyelids to open (without regard to afterburner operation) when the throttles are advanced to OPEN, resulting in very low tailpipe temperatures and extreme loss of thrust. If both inverters fail while in afterburning, afterburner operation will not be affected. However, if the afterburners are shut down by depressing the throttle fingerlifts, the eyelids will remain open. The eyelids can be closed by moving the afterburner control circuit breakers to OFF. Eyelid closure will be apparent by an immediate increase in thrust and a return to normal tailpipe temperature. Only military power will be available for the duration of the flight.

AFTERBURNER DEMAND SWITCHES.

Two afterburner demand switches control afterburner operation. Each switch is connected by mechanical linkage to a fingerlift on each throttle. The switches use 28-volt dc to control the electrical circuits in the automatic afterburner system. Afterburning is initiated by lifting the fingerlift when the throttle is in the 90% to 100% rpm range. A speed-sensing switch for each engine prevents afterburner ignition when engine speed is below 87.5% rpm. When a fingerlift is raised (and engine speed is above 87.5% rpm), the afterburner booster pump in the sump tank starts, the booster pump pressure switch opens the valve that supplies compressor air to the turbine-driven afterburner fuel pump, the main afterburner fuel shutoff valve opens, and "hot-streak" ignition occurs. After the fuel ignites, the eyelids open and afterburning continues. Both afterburners may be ignited at the same time during scrambles or in an emergency. Afterburning is stopped by depressing the fingerlift when the throttle is in the 90% to 100% rpm range or by retarding the throttle below the 90% rpm position. Either action will turn off the afterburner demand switch. The fingerlift does this by direct mechanical linkage, and retarding the throttle does it by means of a cam arrangement in the throttle quadrant. If afterburning is stopped by retarding the throttle, the fingerlift will be lowered to the down position. Stopping afterburning by either method returns all units of the automatic control system to a nonafterburning condition and restores normal engine operation. If the afterburner flames out, the automatic control will shut down the afterburner.

The afterburner will not reignite until the fingerlift is depressed and then raised again while the throttle is in the 90% to 100% rpm range and engine speed is above 87.5% rpm.

AFTERBURNER CONTROL SWITCHES (GROUP 75 AIRPLANES).

Two afterburner control switches (figure 1-25), one on each 28-volt d-c circuit breaker panel, can be used to deenergize the afterburner control circuits during ground operation or in flight if the afterburner mal-

functions. On some airplanes the afterburner control switches are toggle-type circuit breakers; on other airplanes the switches are pushbutton-type circuit breakers. The switch has an ON and an unmarked OFF position. When the switch is placed at ON, the afterburner control circuits are energized; when placed at OFF (unmarked), the circuits are deenergized. If more than 15 minutes are to elapse between supplying power to the 28-volt d-c bus and starting or operating engines above idle rpm, the afterburner control switch should be placed at OFF (unmarked) and left at OFF until just

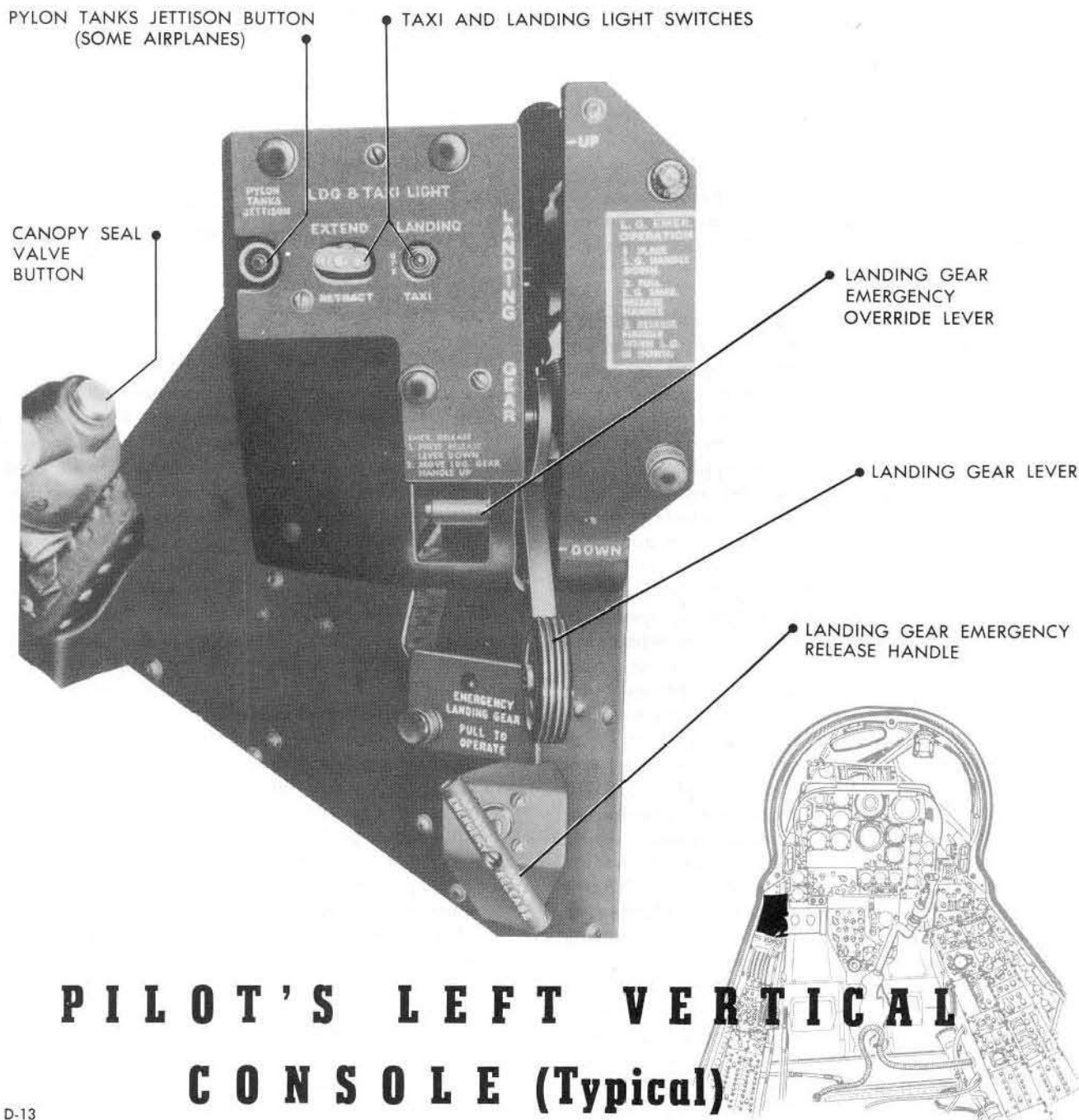


Figure 1-10.

PILOT'S CENTER PEDESTAL

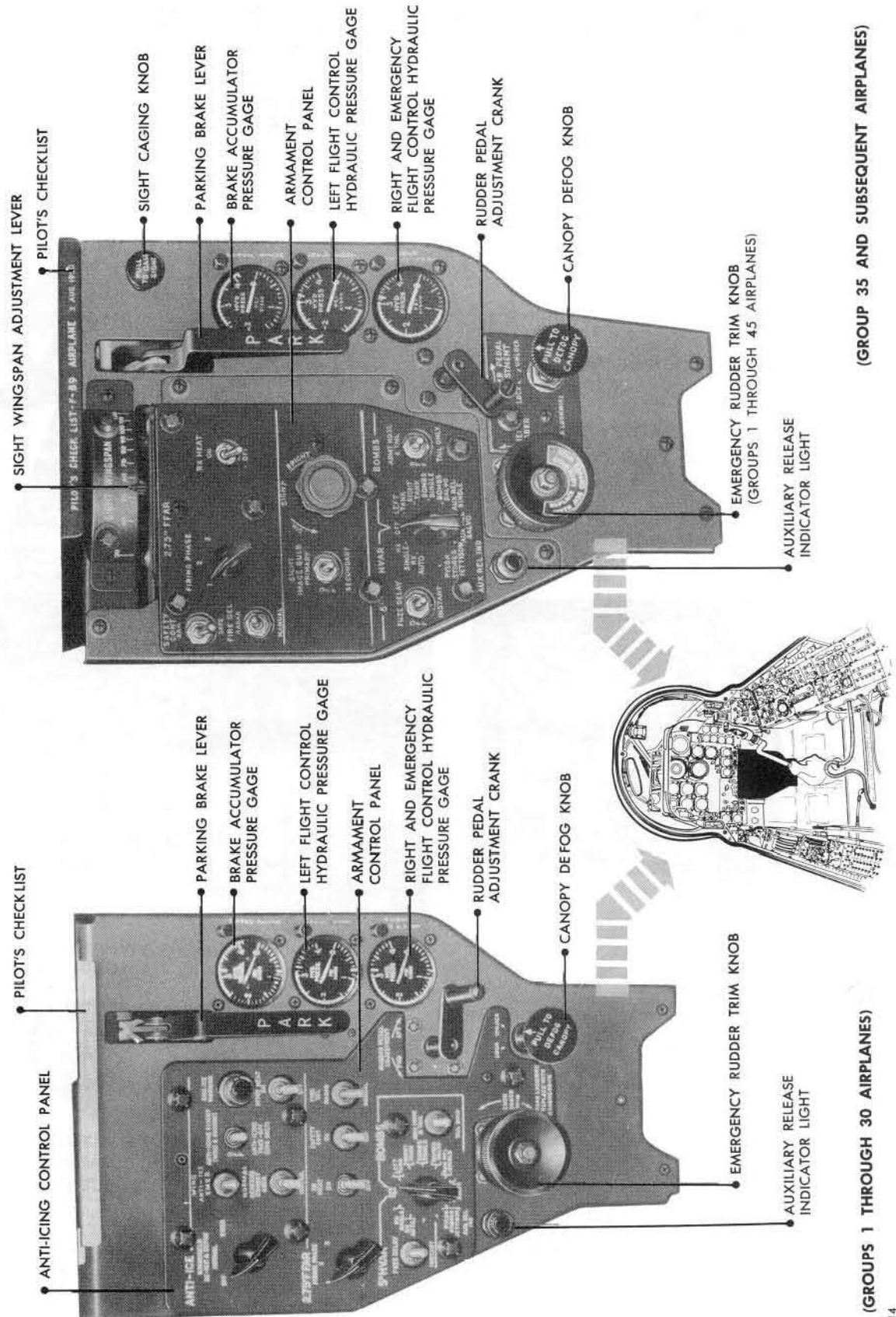


Figure 1-11.

(GROUPS 1 THROUGH 30 AIRPLANES)

(GROUP 35 AND SUBSEQUENT AIRPLANES)

PILOT'S RIGHT VERTICAL CONSOLE (Typical)

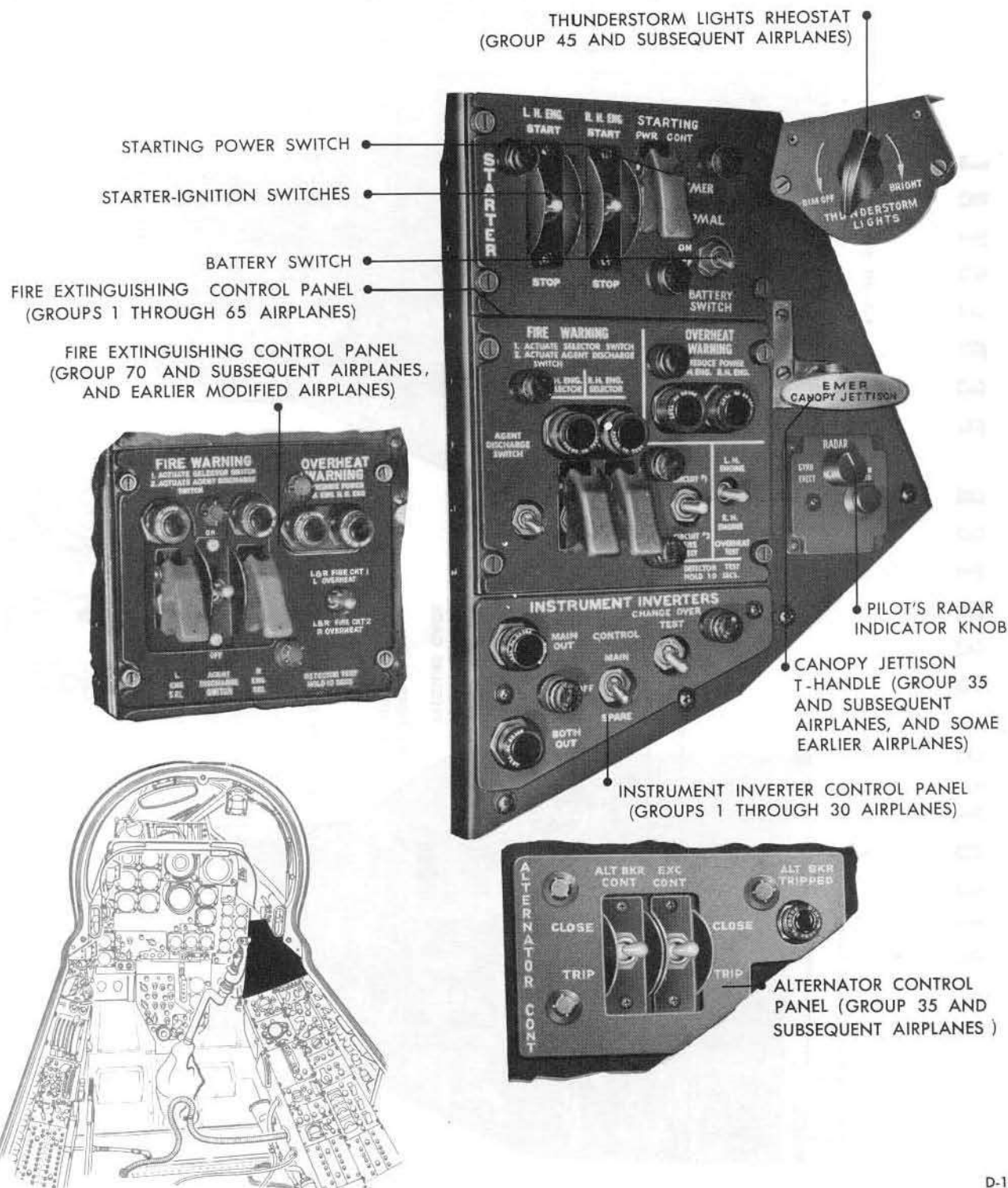


Figure 1-12.

before starting engines. This will deenergize the altitude idle bleed and eyelid actuator solenoids, thus preventing them from being damaged by overheating.

OIL SYSTEM.

Each engine has an independent dry sump, full scavenge oil system. See figure 1-13 for oil quantity data. Oil is gravity fed from the tank, mounted on the outboard side of the engine, to the main engine-driven pump. The main pump distributes the oil under pressure through a filter to the accessory gears and engine bearings. The scavenge side of this same pump returns oil from the accessory and forward engine bearing to the oil tank. A midframe scavenge pump scavenges oil from the mid, damper, and aft bearings, and returns it through a heat exchanger to the oil tank. The heat exchanger uses fuel flow to cool the scavenged oil. This system has no manual controls as its operation is entirely automatic. See figure 1-15 for oil specification and grade.

FUEL SYSTEM (GROUPS 1 THROUGH 70 AIRPLANES).

The airplane has two independent fuel systems, a left and right, with a connecting line and a valve for cross-feeding (see figure 1-16). The tanks in each system include a self-sealing fuselage sump tank, two bladder-type multi-celled wing tanks, a permanently installed metal tip tank, and a jettisonable pylon tank. A self-sealing nose tank supplements both systems. For fuel quantity data see figure 1-14. During normal operation, fuel flows to the engine from the sump tank which is automatically replenished by the pylon tank, tip tank, and the wing tanks. Fuel from pylon tanks and tip tanks is fed to the sump tanks by air pressure drawn from the eleventh stage of the engine compressor and regulated to approximately 9 psi. Pressurization of either pylon tank is controlled manually by individual pylon tank switches on the fuel control panel, and is automatically shut off when a tank is emptied or dropped. There is no manual shutoff for compressor air to the tip tanks which are pressurized whenever either engine is operating. Fuel from the wing tanks is fed by electric booster pumps within the tanks. When the pylon tank is empty, a float switch closes the pylon tank fuel shutoff valve and the air shutoff valve, and opens the tip tank fuel shutoff valve to start the tip tank feeding. When the tip tank is empty, a float switch closes the tip tank valve and opens the wing tank valve to the sump tank; fuel flows from both wing tanks simultaneously to the sump tank. When the wing tanks are empty, the sump tank continues to feed fuel to the engine until a predetermined sump low level (two-thirds full) is reached. At this point a float switch falls, closing a 28-volt d-c circuit that powers both nose tank booster pumps. This switch also opens a valve in the nose tank line thus enabling

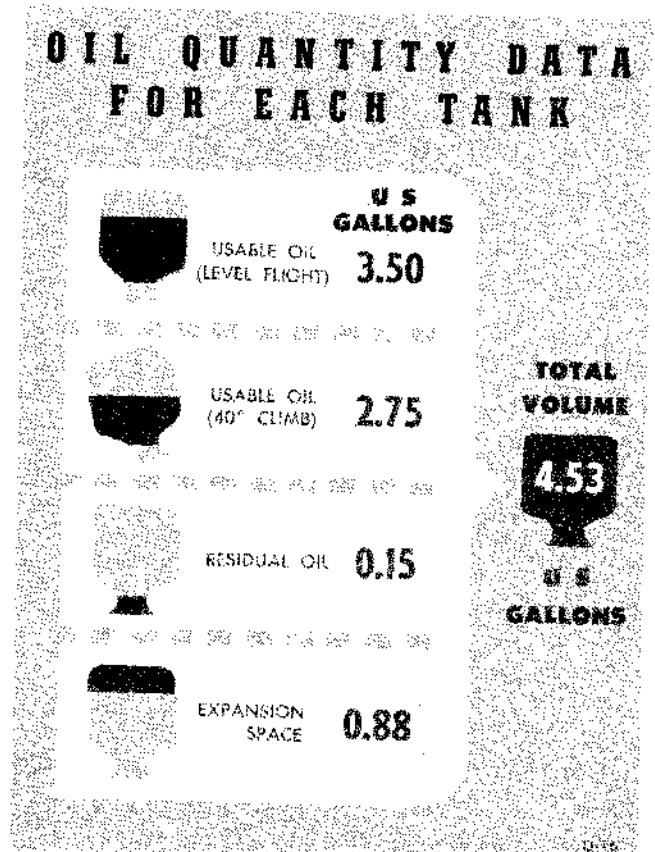


Figure 1-13.

the nose tank to join in feeding directly to the corresponding engine when the sump tank is still more than one-half full. When the other sump tank reaches its equivalent low level, the float switch in that tank falls, the other nose tank valve opens, and the nose tank supplies fuel to both engines; as the sump tanks empty, the nose tank continues to supply fuel to the engines as long as fuel remains. The fuel system may be manually switched out of automatic sequence, and the nose or wing tanks may be selected. If a sump tank float switch fails to start nose tank feeding during normal sequencing, as may be noted by a rapid drop in sump tank fuel quantity, then the nose tank can be manually selected. However, this automatically closes the sump tank fuel shutoff valve and no fuel can go to that engine except from the nose tank. The cross-feed line allows fuel from both systems to feed through one main fuel line during single-engine operation, or allows fuel from one system to supply both engines if the other fuel system fails. Fuel for afterburner operation flows from the sump tank afterburner booster pump through a turbine-driven engine-mounted pump and afterburner fuel regulator to the afterburner manifold. In an emergency, the pylon tanks may be jettisoned and the wing tip fuel may be dumped. For a detailed discussion of fuel system operation, refer to Section VII; for fuel specification and grade, see figure 1-45.

**USABLE FUEL
FULLY SERVICED**

(GROUPS 1 THROUGH
70 AIRPLANES)

TIP (2)	PYLON (2)	OUTBD WING (2)	INBD WING (2)	NOSE (1)	FUSELAGE SUMP (2)
GALLONS POUNDS	GALLONS POUNDS	GALLONS POUNDS	GALLONS POUNDS	GALLONS POUNDS	GALLONS POUNDS
306 1989	300 1950	256 1664 (1346)	104 676	261 1696.5	101 656.5 (98)
308 2002	301 1956.5	262 1703 (1638)	106 689	263 1709.5	103 669.5 (100)

GALLONS

POUNDS

WITH PYLON TANK FUEL 2395 * (2369) TOTAL WITH PYLON TANK FUEL 15,567.5 * (15,398.5)

WITHOUT PYLON TANK FUEL 1795 * (1769) USABLE WITHOUT PYLON TANK FUEL 11,667.5 * (11,498.5)

* (GROUPS 35 THROUGH 70 AIRPLANES)

FUEL QUANTITY DATA

**US GALLONS AND POUNDS (EACH TANK)
BASED ON 6.5 LB/GAL (STANDARD DAY)**

THE WEIGHT OF FUEL REQUIRED
TO FILL TANKS COMPLETELY MAY
DIFFER FROM ONE FILLING TO
ANOTHER BECAUSE OF THE EFFECT
OF TEMPERATURE VARIATION ON
FUEL DENSITY.

DATA AS OF: 15 MARCH 1956
DATA BASIS: CALIBRATION

**USABLE FUEL
FULLY SERVICED**

(GROUP 75 AIRPLANES)

TIP (2)	PYLON (2)	OUTBD WING (2)	INBD WING (2)	RIGHT MAIN	LEFT MAIN
GALLONS POUNDS	GALLONS POUNDS	GALLONS POUNDS	GALLONS POUNDS	GALLONS POUNDS	GALLONS POUNDS
306 1989	300 1950	246 1599	104 676	261 1696.5	196 1274
308 2002	301 1956.5	252 1638	106 689	263 1709.5	206 1300

GALLONS

POUNDS

WITH PYLON TANK FUEL 2369 TOTAL WITH PYLON TANK FUEL 15,398.5

WITHOUT PYLON TANK FUEL 1769 USABLE WITHOUT PYLON TANK FUEL 11,498.5

Figure 1-14.

Booster Pumps.

Each fuselage sump tank contains two booster pumps, one for normal operation and one for afterburner operation. The normal booster pump operates continuously during normal fuel sequencing; the afterburner booster pump starts and operates only when afterburning is selected. Each of the wing tanks contains one booster pump. The wing tank booster pumps are controlled automatically by a float switch in the tip tank and by switches on the pilot's fuel control panel. The tip tank switch on the fuel control panel can be placed at OFF to start the wing tank booster pumps if the tip tank float switch fails. The nose tank contains two booster pumps which operate simultaneously to pump fuel to either or both engines when the fuel in either sump tank reaches a predetermined low level. Moving either fuel selector switch to NOSE TANK position will also start both nose tank booster pumps operating. For additional information on fuel system management, refer to Section VII.

Fuel Filter De-icing System.

A de-icing system is provided for the low-pressure fuel filter on each engine. Should water particles in the fuel freeze on the filters and restrict fuel flow, alcohol can be pumped into each filter. For alcohol specification see figure 1-45; for complete description and operation of this system, refer to Section IV.

Pylon Tank Jettison System.

The pylon tanks can be ejected or released electrically, or in an emergency can be released manually. The ejection system in each pylon includes an ejector mechanism, an electrically ignited propellant charge, and a bomb shackle. When the pylon tank or tanks are ejected, 28-volt d-c power ignites the propellant charge which forcibly ejects the tanks clear of the airplane. When the tanks are either manually or electrically released, they fall by gravity alone. The pylon tanks may be ejected or released singly or in salvo.

CAUTION

When the pylon tanks are manually or electrically released, minor damage to the airplane may occur.

Tip Tank Fuel Dump System.

Each tip tank has a 28-volt d-c motor-driven dump valve in the tip tank tail cone for dumping fuel, under pressure, in an emergency. The tip tank dump pressure is supplied from the engine compressor through the pressure regulator. The fuel is released through an outlet in the tip tank tail cone. If air pressure is not available, fuel in the aft compartment of the tip tank may be dumped by gravity, using the normal dumping procedure as discussed in Section VII.

Note

Tip tank fuel cannot be dumped while the weight of the airplane is on the wheels because the oleo strut ground safety switch breaks the tip tank fuel dump electrical circuit.

Single-Point Fueling System.

For description and operation of the single-point fueling system, refer to Section IV.

FUEL SELECTOR SWITCHES.

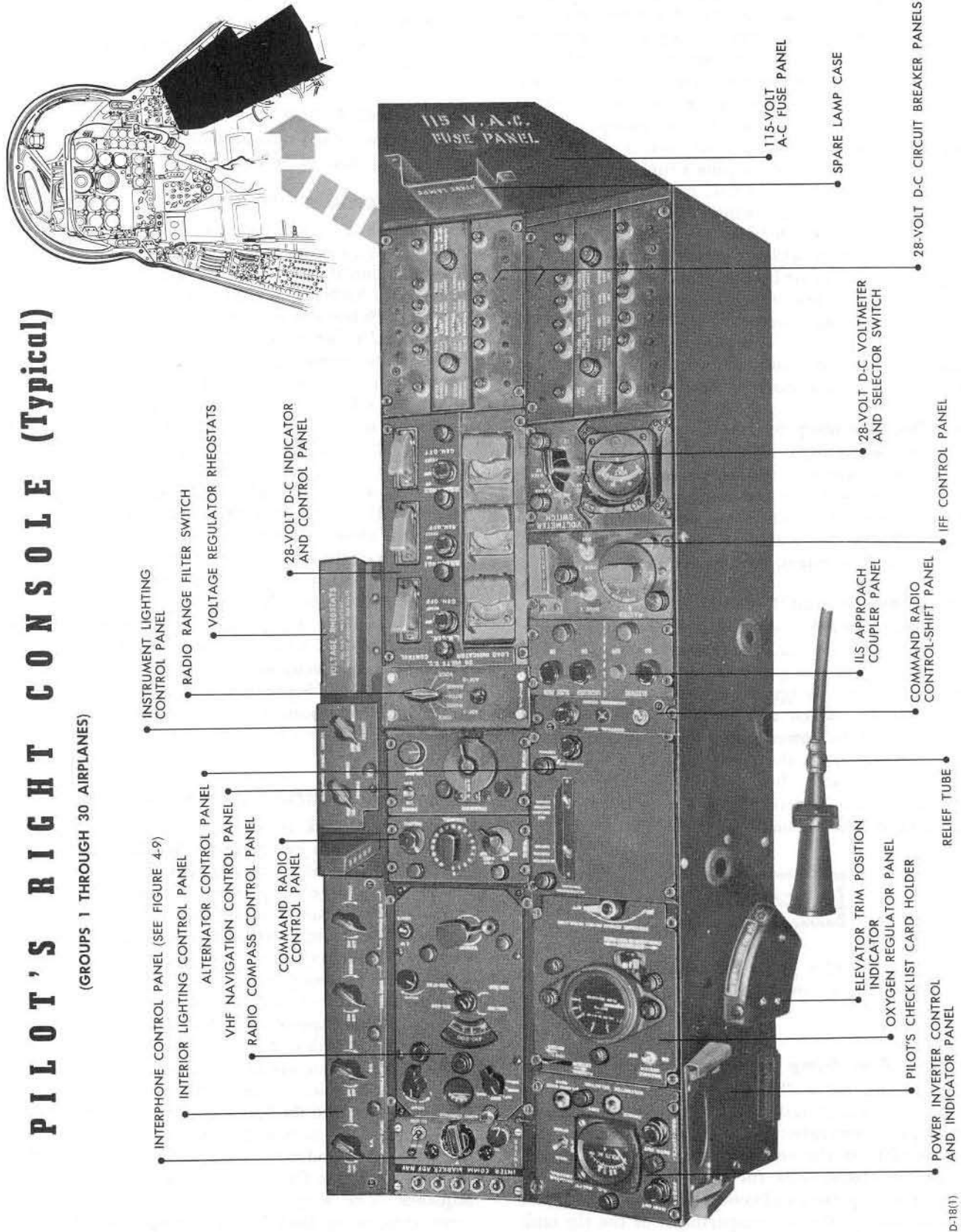
Two 28-volt d-c rotary-type fuel tank selector switches (figure 1-19), one for each fuel system, are located on the fuel control panel, and have the following positions: ALL TANKS, WING TANKS, NOSE TANK, and OFF. When the selector switch is at ALL TANKS and the individual tank switches are at ON (the combination for normal fuel tank sequencing), the normal booster pump in the sump tank operates continuously. When the selector switch is at WING TANKS (with both wing tank switches at ON), the wing tank booster pumps will operate until the switches are turned to OFF. If either selector switch, the left one for example, is moved to NOSE TANK, both nose tank booster pumps will operate, the left sump tank fuel shutoff valve will close, and a shutoff valve will open in the left branch of the nose tank fuel line to the left engine fuel control, allowing only the nose tank to feed directly to that engine. Similar action will take place to supply nose tank fuel to the right engine when the right fuel selector switch is moved to NOSE TANK. When the fuel selector switch is at either ALL TANKS or WING TANKS position, and there is fuel in the sump tank, afterburning can be initiated. For complete information on fuel system management, refer to Section VII.

FUEL TANK SWITCHES AND INDICATOR LIGHTS.

An individual tank switch and a tank indicator light (figure 1-19), both operating on 28-volt dc and located on the fuel control panel, are provided for each tank except the fuselage sump tanks. (Sump tank indicator lights and their function are discussed in a later paragraph.) The switches control individual tank operation and the lights indicate a tank-empty condition or a wing tank booster pump failure if the corresponding tank switches are at ON. For each tank to feed in sequence, the corresponding tank switch must be at ON. When a pylon tank or tip tank empties (tank indicator light burning), moving the tank switch to OFF turns off the tank indicator light and switches the empty tank capacitor into the fuel gage system; when a pylon tank or tip tank fails to feed with fuel remaining in the tank (tank indicator light not burning), turning the tank switch to OFF starts the next tank feeding in sequence. The wing tank switches control the corresponding wing tank booster pumps and the wing tank empty lights. When the wing tanks are feeding in automatic sequence and a wing tank indicator light

PILOT'S RIGHT CONSOLE (Typical)

(GROUPS 1 THROUGH 30 AIRPLANES)

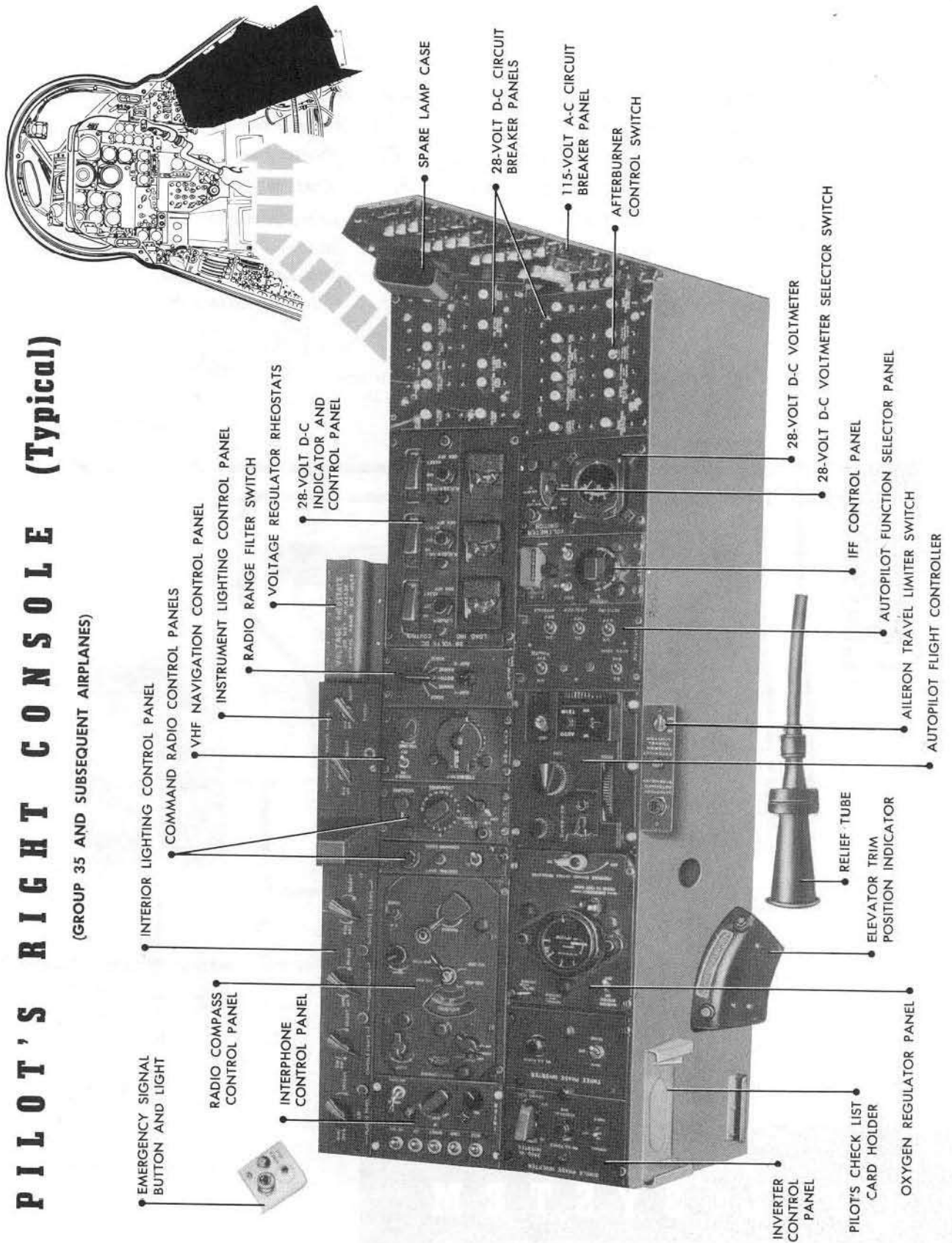


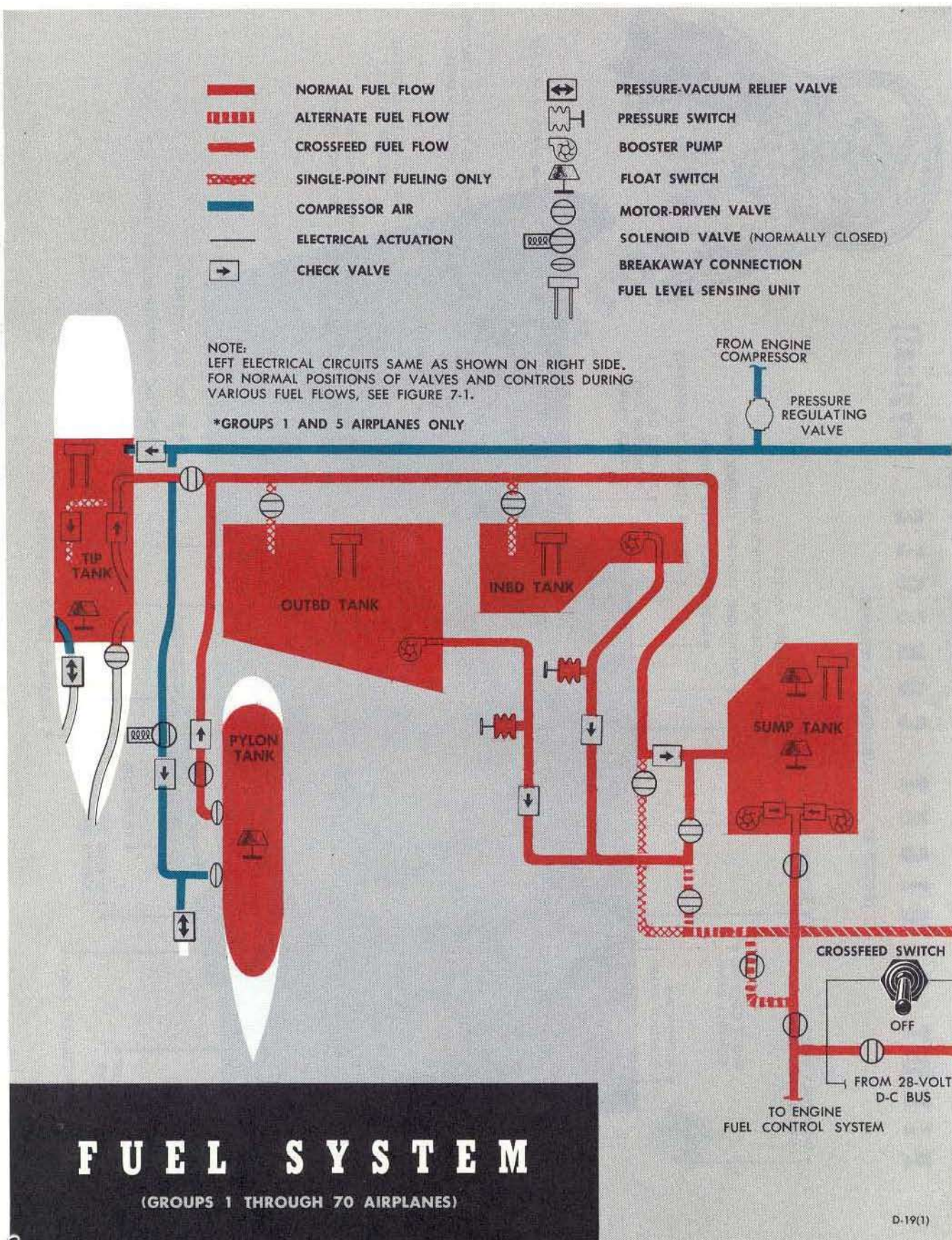
D-18(1)

Figure 1-15.

PILOT'S RIGHT CONSOLE (Typical)

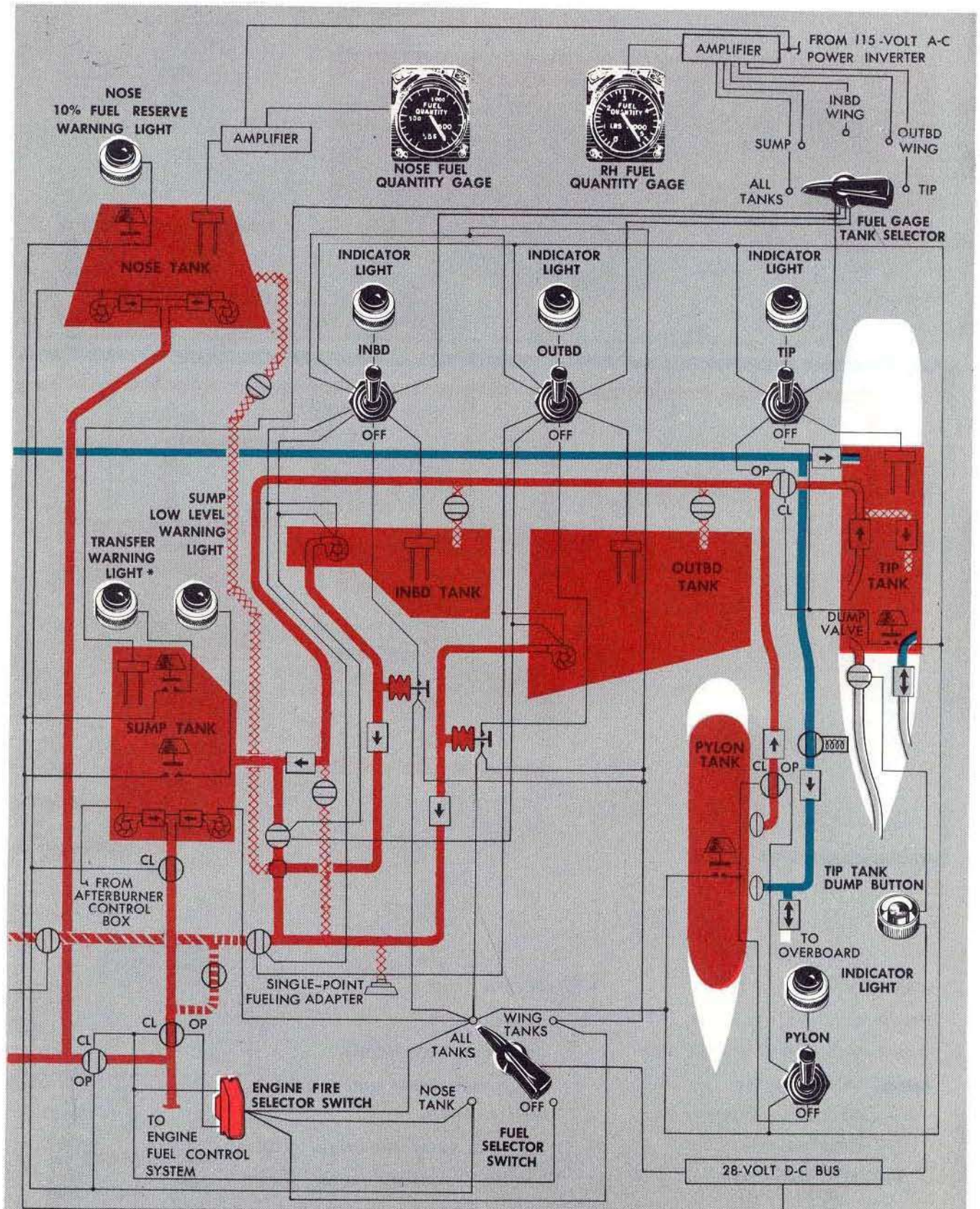
(GROUP 35 AND SUBSEQUENT AIRPLANES)





D-19(1)

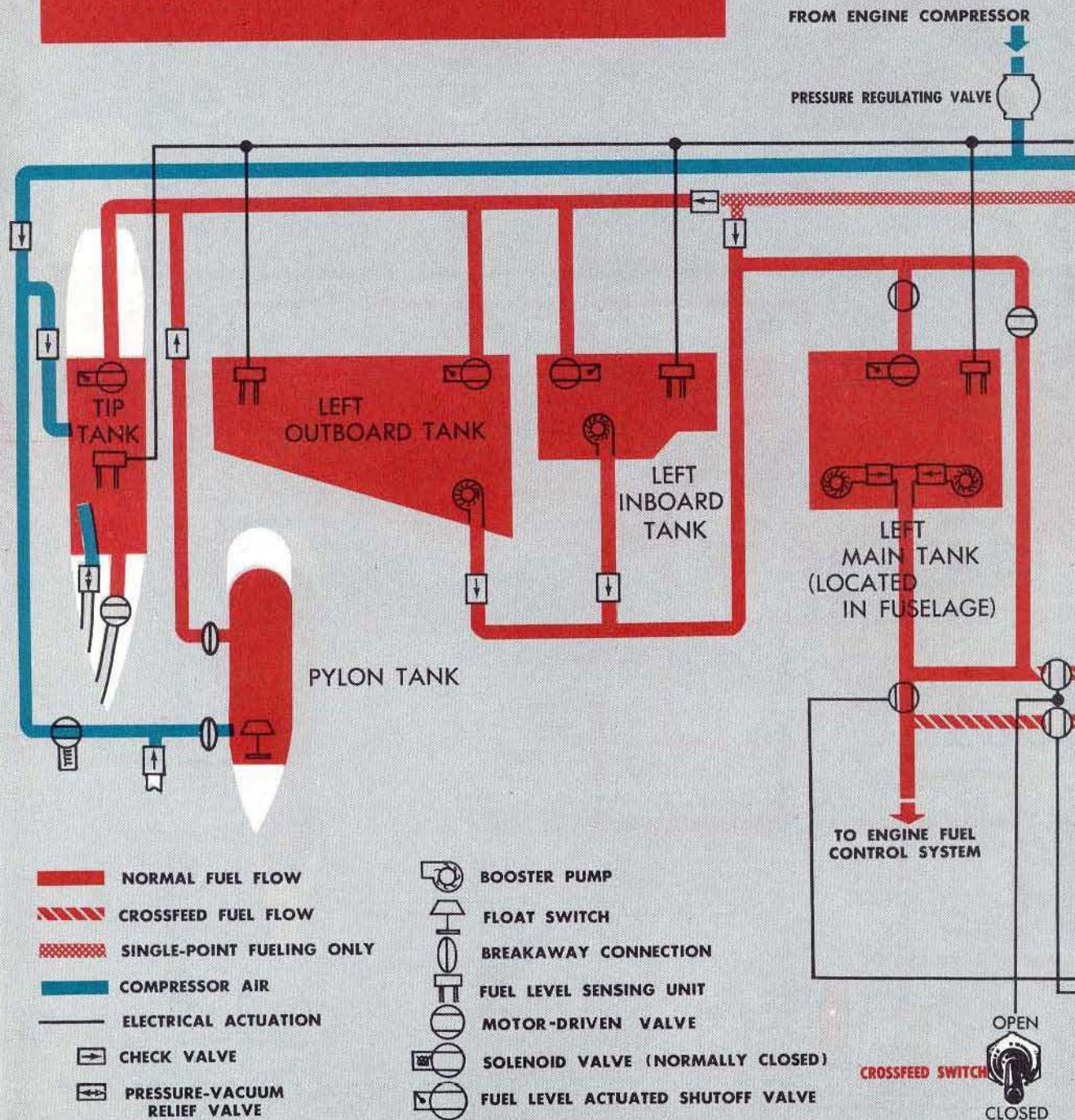
Figure 1-16.



D-19(2)

FUEL SYSTEM

(GROUP 75 AIRPLANES)

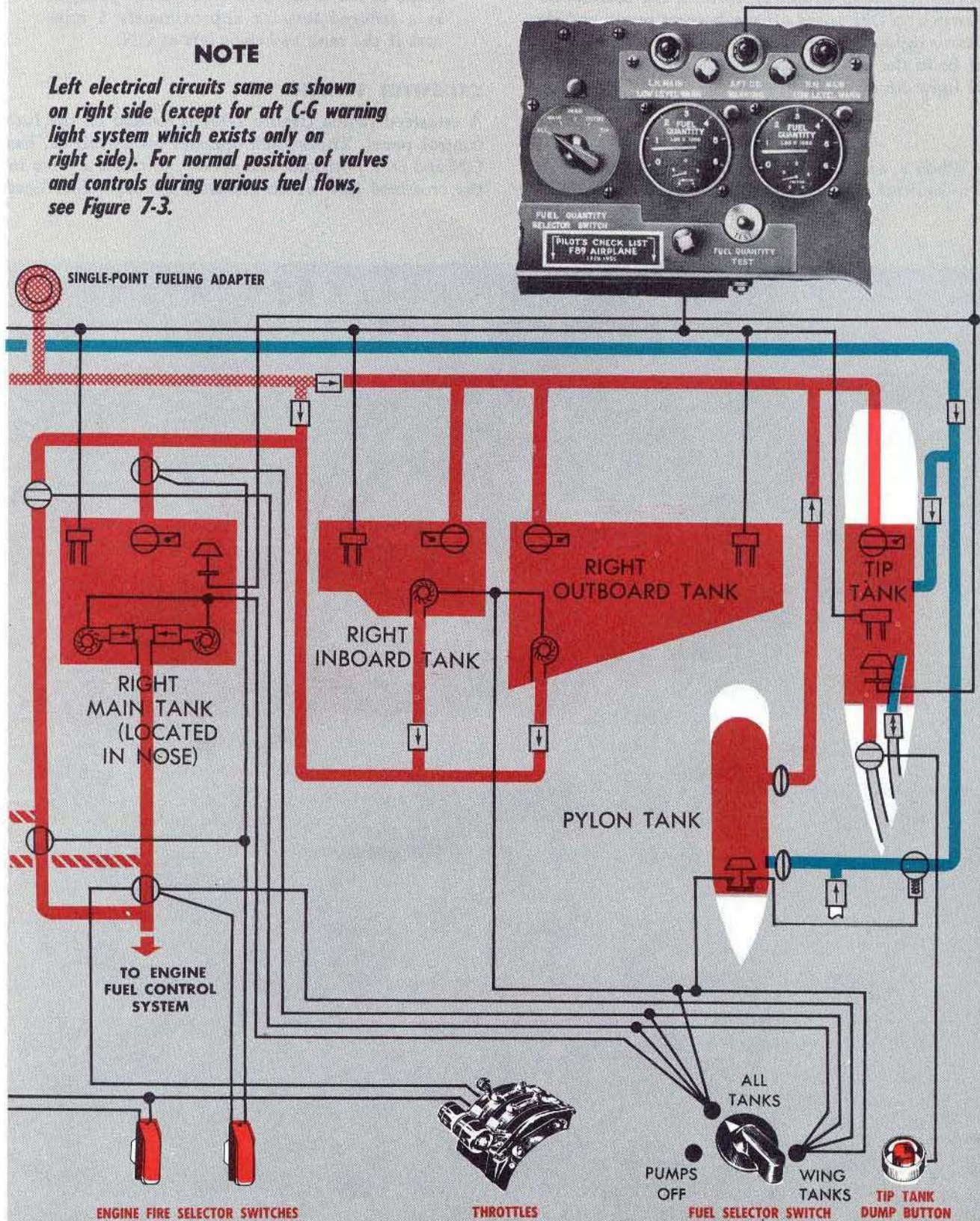


D-19(3)

Figure 1-17.

NOTE

Left electrical circuits same as shown on right side (except for aft C-G warning light system which exists only on right side). For normal position of valves and controls during various fuel flows, see Figure 7-3.



D-19(4)

comes on (indicating an empty tank or a drop in wing tank booster pump pressure), turning the corresponding switch to OFF turns off the booster pump and the indicator light. One or both of the wing tank switches must be in the ON position for the related sump low-level light circuit to be armed.

Note

When a wing tank indicator light comes on to indicate an empty tank, a small amount of

fuel remains because of the relatively flat shape of the tank. This fuel will be pumped at a reduced rate for approximately 5 minutes if the tank switch is left at ON.

CROSSFEED SWITCH.

A crossfeed switch (figure 1-19) is located on the fuel control panel. This switch operates on 28-volt dc, has ON and OFF positions, and opens and closes a valve in the crossfeed line which connects the main fuel lines

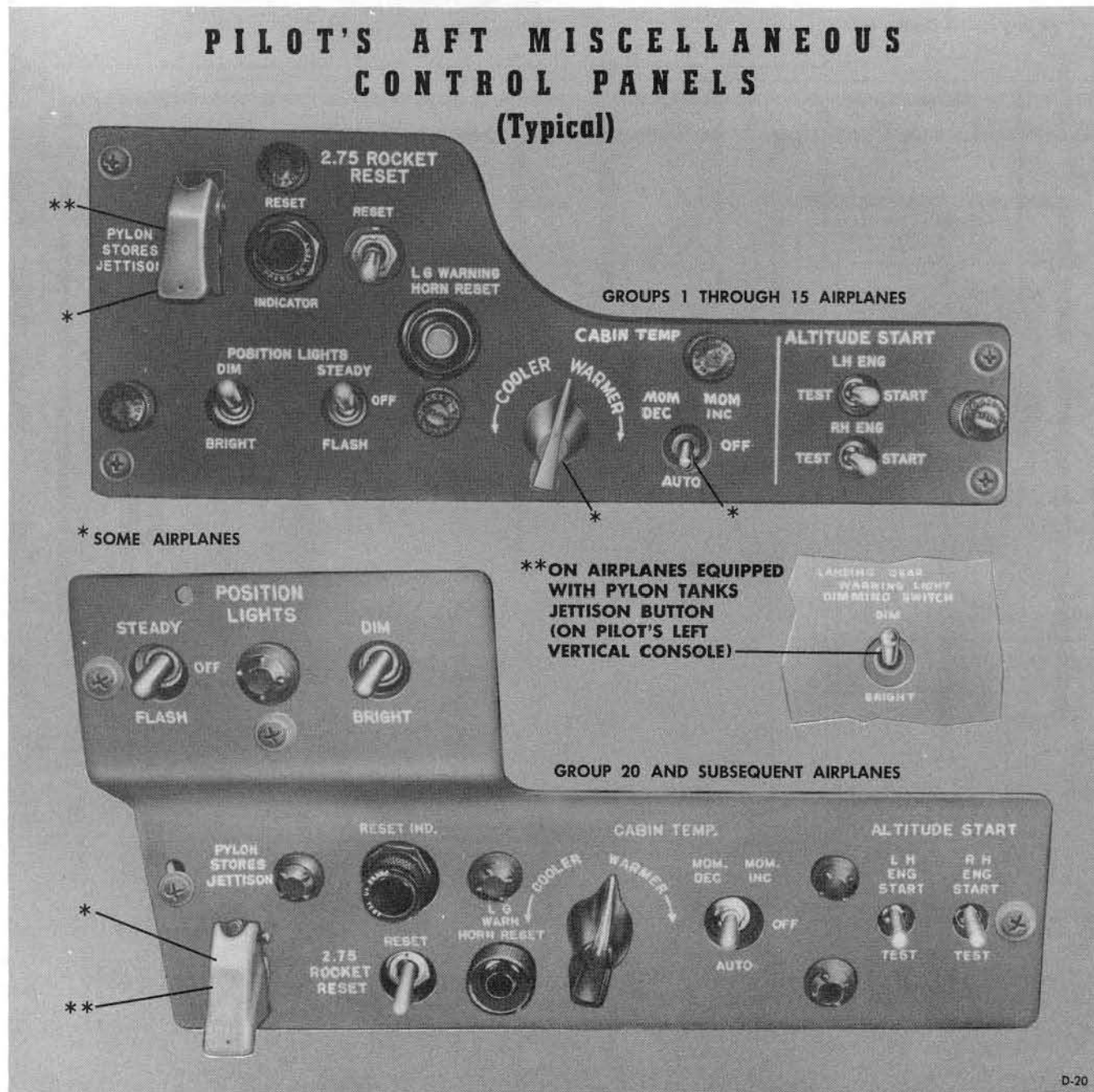


Figure 1-18.

of each system. The switch is normally at OFF and the crossfeed valve is closed. The crossfeed switch is moved to ON only when it is desirable to use the fuel in both systems to feed one engine or to operate both engines on the fuel from one system.

ENGINE FIRE SELECTOR SWITCHES.

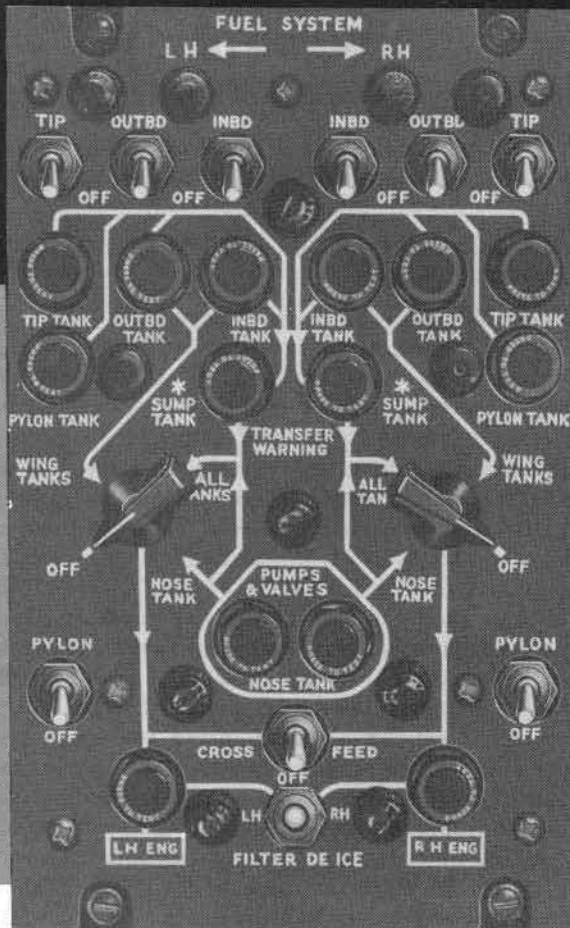
There are two guarded engine fire selector switches (figure 1-41) located on the pilot's right vertical console. Actuating either switch closes the d-c motor-operated main fuel line valve to the engine in the related fuel system and arms the circuit to the fire extinguishing agent discharge switch. These switches operate on 28-volt dc.

PYLON TANK JETTISON SWITCHES.

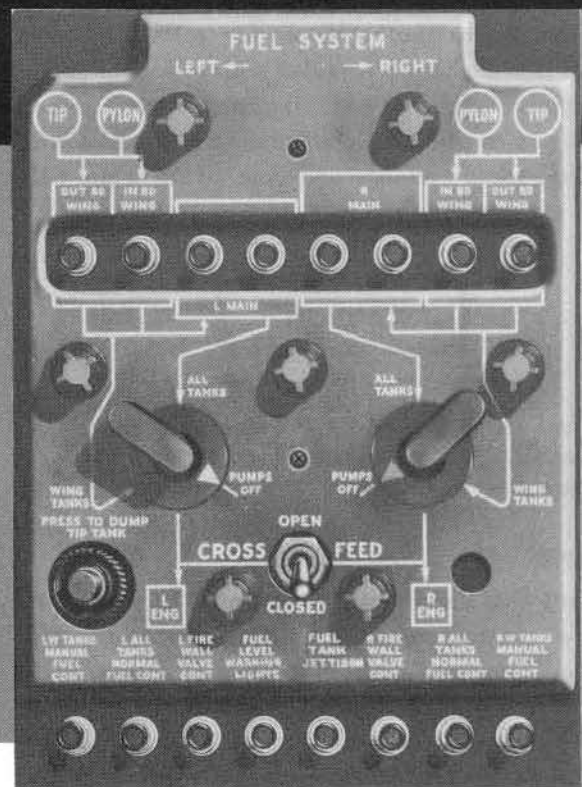
Two switches, using 28-volt dc, control both the electrical ejection and the electrical release of the pylon tanks. Placing the rotary armament switch (figure 4-31), on the bottom of the armament control panel, at LEFT TANK or RIGHT TANK and then pressing the pylon tanks and bombs release button (figure 1-30) on the control stick, ejects the selected tank. The tanks can be released singly by placing the armament switch at BOMBS SINGLE and pressing the button. This releases the left pylon tank; pressing the button again releases the right pylon tank. With the armament switch at either BOMBS SALVO or PYLON STORES JETTISON, pressing the pylon tanks and

FUEL CONTROL PANELS (Typical)

(GROUP 75 AIRPLANES)



(GROUPS 1 THROUGH 70 AIRPLANES)



*SOME AIRPLANES

D-21(1)

Figure 1-19.

bombs release button releases the pylon tanks in salvo. On some airplanes a guarded switch (figure 1-18) marked "Pylon Stores Jettison" is located on the pilot's aft miscellaneous control panel. This switch, operating on 28-volt dc, provides a means of overriding the armament selector switch and the bombs and pylon tanks release button when an emergency requires immediate tank ejection with the least possible action on the part of the pilot. Raising the guard and moving the switch up, bypasses the armament selector switch and energizes the circuits to fire both pylon tank ejectors in salvo, ejecting both tanks without the movement of any other switches or controls. Group 40 and subsequent airplanes and some earlier airplanes are provided with a button-type switch (figure 1-11) marked "Pylon Tanks Jettison" and located on the pilot's left vertical console. This button, when pressed, ejects the pylon tanks in the same manner as the pylon stores jettison switch.

EXTERNAL STORES EMERGENCY RELEASE HANDLE.

The external stores emergency release handle (figure 1-9) is stowed on the pilot's left console just outboard of the throttle quadrant. The handle is linked by cables and bellcranks to the bomb shackle release in each pylon. When the handle is pulled with a force of about 50 pounds to its limit of travel (approximately 7 inches from its stowed position), the pylon tank shackles will be tripped simultaneously and both pylon tanks will drop by gravity.

CAUTION

When the pylon tanks are jettisoned either manually or electrically (gravity drop), minor damage to the airplane may result.

TIP TANK FUEL DUMP BUTTON.

A tip tank fuel dump button (figure 1-20) on the fuel accessory control panel is used to dump the tip tank fuel. Pressing this button operates a time-delay relay, operating on 28-volt dc, which opens both tip tank dump valves for approximately 75 seconds. The normal time required to dump a full tip tank is approximately 60 seconds. Because of the aft location of the dump valves, the tanks cannot be completely drained during decelerations or dives. For complete drainage, the airplane must be in level or climbing flight. Tip tank fuel cannot be dumped while the weight of the airplane is on the wheels.



Figure 1-20.

WARNING

Do not attempt to dump fuel during rocket firing because of the fire hazard.

FUEL QUANTITY GAGES AND FUEL GAGE TANK-SELECTOR SWITCH.

Three fuel quantity gages (figure 1-21), operating on 115-volt ac, and a five-position fuel gage tank-selector switch, operating on 28-volt dc, all located on the pilot's instrument panel, enable the pilot to check the fuel quantities in the entire fuel system or in the individual tanks. When the gage tank selector is turned to ALL, the right and left quantity gages indicate in pounds the total fuel available to the engines in the right and left systems. When the tank selector is turned to SUMP, INBD WING, OUTBD WING, or TIP, the left and right gages will show the quantity of fuel in the selected tanks. The nose tank gage indicates only the quantity of fuel in the nose tank and is not affected by the gage tank-selector switch. (Pylon tank fuel quantities are not included in the fuel gage system.) The fuel quantity gaging system is the electric capacitance-type employing tank units that produce electric signals proportional to the fuel level at each tank unit. The tank units are calibrated individually to match the shape of the particular tank so that the signal, when amplified and fed through a bridge circuit, will give a linear reading on the gage indicator regardless of the varying cross-sectional area of the tank at different fuel levels. The tank units are compensated for changes in temperature and fuel density so that any variation in accuracy due to these factors is negligible. The right and left fuel quantity gage systems include totalizers that add the quantity indications from the various

The instrument panel features a fuel gauge and tank selector on the left, and three fuel quantity gauges on the right. The fuel gauge and tank selector has a needle pointing to 'ALL' and a 'TIP' label. The three fuel quantity gauges are labeled 'L.H. FUEL', 'NOSE FUEL', and 'R.H. FUEL'. Each gauge has a scale from 0 to 5 and a 'FUEL QUANTITY' label. Below each gauge is a 'FUEL PRESS TO TEST' button.

(GROUP 75 AIRPLANES)

1-31

fuel tanks in either the right or left systems and show a total usable fuel quantity on the corresponding gage. The switch settings that will provide this indication are as follows: fuel selector switch at ALL TANKS; fuel gage tank-selector switch at ALL; individual tank switches at ON unless tanks are known to be empty or contain fuel that is unusable due to fuel system malfunction. (If either case is true, the tank switch for the affected tank should be turned to OFF.)

Note

On Groups 1 through 35 airplanes, tip tank fuel will be included in the total fuel quantity when the tip tank switch is at OFF, provided the pylon tank switch is at ON and fuel is in the pylon tank. On Group 40 and subsequent airplanes, the tip tank switch must be at ON to read tip tank fuel. On Groups 1 through 35 airplanes modified in accordance with T.O. 1F-89D-512, tip tank fuel quantity gaging can be cut off when the tip tank override switch is at the OFF position to provide a more accurate usable fuel reading.

To verify that the gages are operating, each fuel quantity gage is provided with a button-type press-to-test switch, located below each gage on Groups 1, 5, and 10 airplanes, and above each gage on Groups 15 through 70 airplanes. Pressing one of these test switches causes the needle of the related gage to swing to the lower side of the dial to an off-scale position, showing that the gage system is energized. Releasing the switch button causes the needle to return to its original position, indicating proper functioning of that fuel quantity gage system.

SUMP LOW-LEVEL WARNING LIGHTS.

There are two sump low-level warning lights (figure 1-8) on the pilot's instrument panel. The lights operate on 28-volt dc and serve to indicate when the sump fuel is below the two-thirds full level. On Groups 1 and 5 airplanes the fuel selector switch must be at ALL TANKS and at least one wing tank switch must be at ON to arm the corresponding sump low-level warning light. On Groups 10 through 70 airplanes the fuel selector switch need not be at ALL TANKS, but at least one wing tank switch must be at ON to arm the corresponding sump low-level warning light. On Group 75 airplanes the sump low-level warning lights operate independently of the fuel system switches. Each light is connected to a float switch in the corresponding sump tank. When the fuel in a sump tank drops to about 450 pounds remaining, the float switch closes and turns on the related warning light. The light will go out when the sump tank has been replenished to the two-thirds full level.

WARNING

It is possible to encounter a double flameout without getting sump low-level warning light indications if all your wing tank booster pump switches are at OFF, since the switches will disarm the lights when placed at OFF.

FUEL TRANSFER WARNING LIGHTS (GROUPS 1 AND 5 AIRPLANES).

Two 28-volt d-c fuel transfer warning lights (figure 1-19) on the fuel control panel, one for each fuel system, will come on during automatic sequencing to indicate when sump tank fuel is being used faster than it is being replenished. When the sump tank fuel falls a few gallons below the full level, as may occur during automatic sequencing when the engines are using fuel faster than the sump tanks are being replenished, a float switch closes and the warning light comes on. The lights are armed only when the fuel selector switch is set at ALL TANKS and when one or both wing tank switches are at ON. On airplanes in compliance with T.O. 1F-89D-512, the fuel transfer warning lights have been removed.

NOSE TANK WARNING LIGHTS.

A single nose tank fuel reserve red warning light (figure 1-8) on the pilot's instrument panel illuminates when only 1220 pounds of fuel remain in the nose tank. This is approximately ten percent of the airplane's total fuel (excluding pylon tank fuel). Two nose tank warning lights, operating on 28-volt dc, are located on the fuel control panel indicate the failure of the nose tank booster pumps or the valves in the fuel line from the nose tank to the engines. For details on identifying trouble indicated by these lights, refer to Section VII.

FUEL SYSTEM (GROUP 75 AIRPLANES).

The airplane has two independent fuel systems, a left and right, with interconnecting lines and valves for crossfeeding (figure 1-17). Each system has a main fuselage tank, two multicelled wing tanks, a permanently installed tip tank, and a jettisonable pylon tank. The right system main tank is in the nose section; the left system main tank is in the aft fuselage. For fuel quantity data, see figure 1-14. During normal operation fuel is pumped to the engines from the main tanks which are automatically replenished from the wing tanks. As wing tank fuel level is lowered, fuel from pylon and tip tanks flows simultaneously into the wing tanks under air pressure from the engine compressors. Fluid level actuated valves within the wing tanks close when the tanks become full to prevent overfilling and pressurization. Pressurization of pylon and tip tanks is automatically regulated

at 5 to 6 psi. Transfer of fuel from these tanks will continue until pylon and tip tank fuel supply is exhausted or jettisoned. When a tip tank empties, a fluid level actuated shutoff valve within the tank closes the fuel line from the empty tank to the wing tanks. When a pylon tank empties, a float switch is actuated, causing a solenoid valve in the pylon air pressurization line to close. After the wing tanks become empty, the main tanks continue to supply fuel to the engines. When the main tank fuel level is lowered to the 100-gallon (650-pound) level, a low-level red warning light on the pilot's instrument panel will illuminate. For all normal operation, fuel flow sequence is completely automatic; however, wing tanks may be selected and fuel will be pumped directly from wing tanks to the engine. Crossfeed operation permits both engines to operate from either fuel system, or permits single-engine operation from either or both fuel systems. Fuel for afterburning is pumped from the main fuel line to a turbine-driven pump on each engine, through the afterburner fuel regulators, and then to the afterburners. For fuel specification and grade, see figure 1-45.

Booster Pumps.

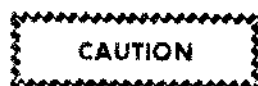
Each of the two fuel systems has four 28-volt d-c booster pumps, one in each of the wing tanks and two in each main tank. During normal operation all booster pumps operate continuously. The pumps are designed for sustained operation wet or dry and, therefore, can operate in an empty tank.

Fuel Filter De-icing System.

An engine fuel filter de-icing system is provided for the engines. Alcohol can be injected into the low-pressure fuel filters to dissolve any ice accumulation in the filters and/or engine fuel control. For further description and operating procedure for this system, refer to Section IV. For alcohol specification, see figure 1-45.

Pylon Tank Jettison System.

The pylon tanks may be jettisoned electrically or manually. When pylon tanks are electrically jettisoned, 28-volt d-c power ignites a propellant charge which forcibly ejects the tanks clear of the airplane. When the tanks are manually released, they fall by gravity alone.



When the pylon tanks are jettisoned either manually or electrically (gravity drop), minor damage to the airplane may result.

Tip Tank Fuel Dump System.

Each tip tank has a 28-volt d-c motor-driven dump valve located in the tip tank tail cone. When these valves are opened, fuel is forced overboard under normal tip tank air pressure through an outlet in the tail cone at a rate that will normally empty a full tip tank in approximately 90 seconds. The valves are held open for a minimum of 90 seconds by a time-delay relay. Tip tank fuel will not be completely dumped during decelerations or dives; however, a new dumping cycle may be initiated if required.

Single-Point Fueling System.

For description and operation of the single-point fueling system, refer to Section IV.

FUEL SELECTOR SWITCHES.

Two rotary 28-volt d-c selector switches (figure 1-19), one for each system, are located on the fuel control panel. Each switch has ALL TANKS, WING TANKS, and PUMPS OFF positions. When a selector switch is at ALL TANKS, all booster pumps of the related system operate continuously and fuel sequencing is automatic: pylon and tip tanks feed the wing tanks, wing tanks feed the main tank, and the main tank feeds the engine. When a selector switch is at WING TANKS, only the wing tank booster pumps in the related system operate and fuel is routed directly from wing tanks to the engine; however, pylon and tip tanks will continue to replenish the wing tanks. When a selector switch is at PUMPS OFF, all booster pumps in that system are shut down. Group 75 airplanes in compliance with T.O. 1F-89-611 are modified to interlock the starter control circuit with the fuel selector switches, making it impossible to start an engine with its fuel selector in the PUMPS OFF position. This modification prevents loss of afterburner power during takeoff but has no effect on loss of afterburner power due to system malfunction or PUMPS OFF switch settings made after starting engines.

Note

Placing the selector switch at PUMPS OFF does not close the firewall fuel shutoff valves. These valves will close when the throttle is moved to the closed position or when the engine fire selector switch is actuated.

CROSSFEED SWITCH.

A 28-volt d-c crossfeed switch (figure 1-19), located on the fuel control panel, has OPEN and CLOSED positions. When the crossfeed switch is at OPEN, the main fuel lines of both systems are interconnected; both fuel systems may be used to operate one engine or both engines may be operated from either fuel system. Unbalanced lateral fuel loading (wing heaviness) may be corrected by feeding both engines from the system having the most fuel. To balance fuel load,

place the crossfeed switch at OPEN and the fuel selector switch for the system with less fuel at PUMPS OFF. When fuel load is balanced, as indicated by lateral trim or fuel quantity gages, return the selector switch to ALL TANKS and the crossfeed switch to CLOSED.

ENGINE FIRE SELECTOR SWITCHES.

Two guarded 28-volt d-c engine fire selector switches (figure 1-41), one for each engine, are located on the pilot's right vertical console. Lifting the guard and placing either switch in the UP position arms the fire extinguishing agent discharge switch and closes the fuel shutoff valves necessary to isolate the related engine from its fuel supply.

THROTTLE-ACTUATED FUEL SHUTOFF SWITCHES.

Two 28-volt d-c throttle-actuated fuel shutoff switches, one for each engine, are actuated when the throttles are moved to the closed position. Actuation of these switches closes the firewall fuel shutoff valves.

Note

If the right engine fuel selector switch is at WING TANKS, the related throttle-actuated fuel shutoff switch will not isolate the engine from its fuel supply.

PYLON TANK JETTISON SWITCH.

A 28-volt d-c pushbutton switch (figure 1-11) marked "Pylon Tanks Jettison" is located on the pilot's left vertical console. When the button is pressed, both pylon tanks are forcibly ejected simultaneously.

EXTERNAL STORES EMERGENCY RELEASE HANDLE.

An external stores emergency release handle (figure 1-9) is located on the pilot's left console. This emergency release handle is linked by cables and bellcranks to the bomb shackle release in each pylon. When the handle is pulled out approximately 7 inches with a force of approximately 50 pounds, both right and left bomb shackles will be tripped simultaneously and both pylon tanks will drop by gravity.

CAUTION

When the pylon tanks are jettisoned either manually or electrically (gravity drop), minor damage to the airplane may result.

TIP TANK FUEL DUMP BUTTON.

A 28-volt d-c pushbutton switch (figure 1-19) marked "Press To Dump Tip Tank" is located on the fuel control panel. When momentarily pressed, this switch operates a time-delay relay which opens right and left

tip tank dump valves for a minimum of 90 seconds. A full tip tank will normally dump in approximately 70 seconds; however, during dives or decelerations, all tip tank fuel will not be dumped. A new dumping cycle may be initiated if required.

FUEL QUANTITY GAGES AND SELECTOR SWITCH.

Two 115-volt a-c fuel quantity gages and a five-position 28-volt d-c rotary tank gage selector switch (figure 1-21), located on the pilot's instrument panel, enable the pilot to read total fuel quantity or individual tank quantities. Positions of the gage selector switch are ALL, MAIN, INBD, OUTBD, and TIP. (Pylon tank fuel is not included in the fuel quantity gage system.) When the gage selector switch is placed at ALL, total fuel in each system is indicated on the respective quantity gage; placing the switch at any individual selection will indicate only the amount of fuel in the particular tank selected. Capacitance-type fuel probes are located in each tank and vary an electrical signal in proportion to fuel level; the resultant signal changes are reflected on quantity gages calibrated in pounds of fuel. To determine that the gages are operating, a 28-volt d-c press-to-test switch, common to both gages, is provided on the panel between the two quantity gages. Pressing this switch causes the needles of the gages to swing to an off-scale position; releasing the switch causes the needles to return to their original positions, thus indicating that the fuel quantity system is functioning.

FUEL SYSTEM WARNING LIGHTS.

One aft cg and two low-level warning lights, all operating on 28-volt d-c, are located on the pilot's instrument panel immediately above the fuel quantity indicators. Each low-level warning light is operated by a float switch in each related main tank and will come on when main tank fuel is lowered to the 100-gallon (650-pound) level. The aft cg warning light is operated by, and in series with, two float switches, one located near the full level of the right main tank and one located near the empty level of the right tip tank. The aft cg warning light will come on when the main tank fuel level is lowered 50 gallons (325 pounds) from full with any fuel, above residual, remaining in the right tip tank. When the aft cg warning light comes on, airspeed must be reduced to Mach 0.65. For discussion on center of gravity limitations, refer to Section V; for corrective action for aft cg warning, see Section III.

ELECTRICAL POWER SUPPLY SYSTEMS.

One direct-current system and three alternating-current systems supply the electrical power. The 28-volt d-c system obtains power from three engine-driven generators, one on the left engine and two on the right engine. A 24-volt, 36 ampere-hour storage battery in the nose serves as standby for the d-c circuit. The d-c

generator on the left engine and one of the d-c generators on the right engine function also as starters. Full generator output is reached at 35% engine rpm. Alternating current is supplied by a constant-frequency 115-volt a-c single-phase (power) inverter system, a constant-frequency 115-volt a-c three-phase (instrument) inverter system, and a variable-frequency 200/115 volt a-c three-phase alternator system. Each inverter system has two inverters. On Groups 1 through 30 airplanes, the main inverter of each system receives power from the 28-volt d-c secondary bus (energized when two or more 28-volt d-c generators are operating) and the spare inverters receive power from the 28-volt d-c primary bus. On Group 35 and subsequent airplanes, all four inverters, two for each system, are powered by the primary 28-volt d-c bus. A variable-frequency alternator mounted on the left engine supplies power for the 200/115-volt a-c three-phase alternator system. The alternator supplies current at frequencies ranging from 380 to 900 cycles, depending on engine speed, for heating systems and sighting equipment. External a-c power is required for ground operation and starting. The external power receptacles for the 28-volt d-c system and 115-volt a-c alternator system are on the right engine air intake duct.

Electrically Operated Equipment.

For complete reference of power distribution to electrically operated equipment, see figure 1-22 and figure 1-23.

External Power Receptacles.

On Groups 1 through 25 airplanes, four external power receptacles (figure 1-3) are located on the right engine air intake. The two top receptacles provide for connecting external 28-volt d-c power to the engine starter system. The third receptacle is for connecting external power to the 28-volt d-c primary bus. The lowest (fourth) receptacle is used for supplying the alternator circuit with an external source of 115-volt 400-cycle a-c power. For starting engines, two leads from a 28-volt d-c starting power source must be plugged into the two uppermost receptacles, and the lead from a separate 28-volt d-c source must be plugged into the third d-c receptacle. On Group 30 and subsequent airplanes, the top receptacle has been eliminated and the starting power system, formerly supplied by two leads from an external 28-volt power source, is supplied from one external lead plugged into the upper of the two 28-volt d-c receptacles. The function of the remaining 28-volt d-c receptacle is to supply power to the primary and secondary 28-volt d-c bus. The function of the 115-volt a-c receptacle remains the same.

28-VOLT D-C SYSTEM.

The 28-volt d-c system obtains power from three engine-driven generators, one on the left engine and two on the right engine. The d-c generator on the left engine and one of the d-c generators on the right engine

function as starter-generators, cranking the engines until the electrical load drops to about 200 amperes (approximately 26% rpm), and then cutting in as generators after engine speed reaches 28% rpm. Three bus bars provide for distribution of direct current: a battery bus, a primary bus, and a secondary bus. When the engines are being cranked, reverse-current relays disconnect the d-c generators from all but the starter bus. When the engines are operating, the three d-c generators supply both the primary bus and the secondary bus, and the two bus bars are interconnected by a bus-tie relay. Failure of any two generators will separate the two buses and the remaining d-c generator will supply power to the primary bus only. A 24-volt 36 ampere-hour storage battery is connected in series to the main 28-volt d-c bus through the battery relay. If the 28-volt d-c generator system fails, the battery will operate essential 28-volt d-c equipment for a limited time. If an emergency start is necessary, with only one 28-volt d-c external power source available, an emergency bus-tie relay (through the emergency start switch) connects the main 28-volt d-c bus (energized by plugging external power into the lowest d-c receptacle) to the starter bus. With the exception of the battery switch on the pilot's right vertical console, all controls and indicators for the 28-volt d-c system are on the pilot's right console.

Battery Switch.

The battery switch (figure 1-12), located on the pilot's right vertical console, connects the battery bus with the 28-volt d-c primary bus and has ON and OFF positions. When the switch is at ON, the battery bus is connected to the 28-volt d-c primary bus. Whenever the 28-volt d-c system is operating and the battery switch is ON, the battery is being charged. When the switch is at OFF, the circuit connecting the battery bus to the primary bus is broken.

CAUTION

The battery switch must not be turned to ON when the external 28-volt d-c starting power supply is being used to start the engines, as damage to the battery will result.

28-Volt D-C Voltage Regulator Rheostat Knobs.

Three voltage regulator rheostat knobs (figure 1-24), one for each 28-volt d-c generator, are located under a hinged cover next to the 28-volt d-c indicator and control panel on the pilot's right console. The 28-volt d-c generator voltage output can be increased or decreased by turning the voltage regulator rheostat knobs toward INCR or DEC. The voltage regulators are normally preset on the ground by qualified maintenance personnel and should not be readjusted in flight unless the voltage output is abnormal.

ELECTRICAL POWER DISTRIBUTION

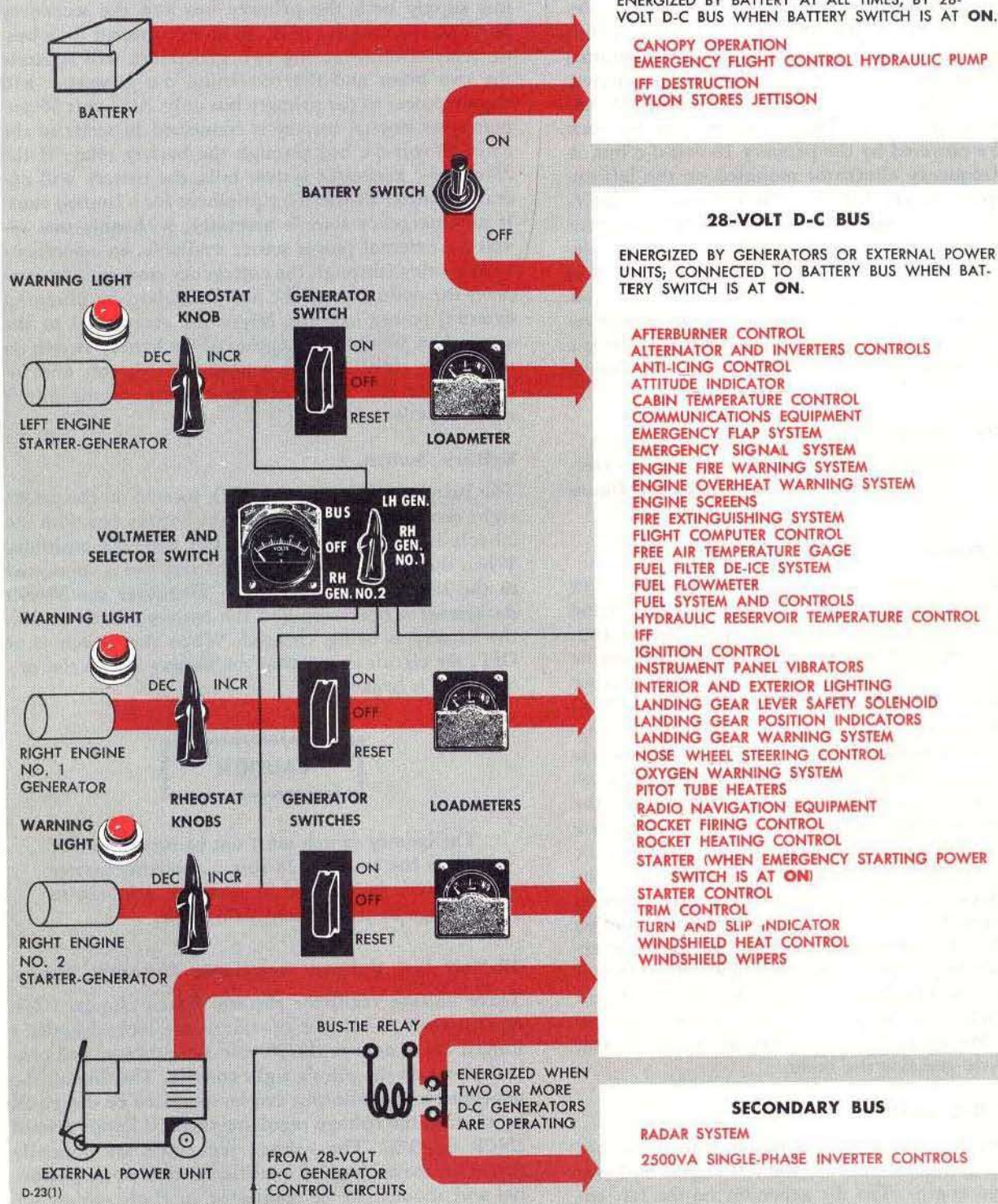
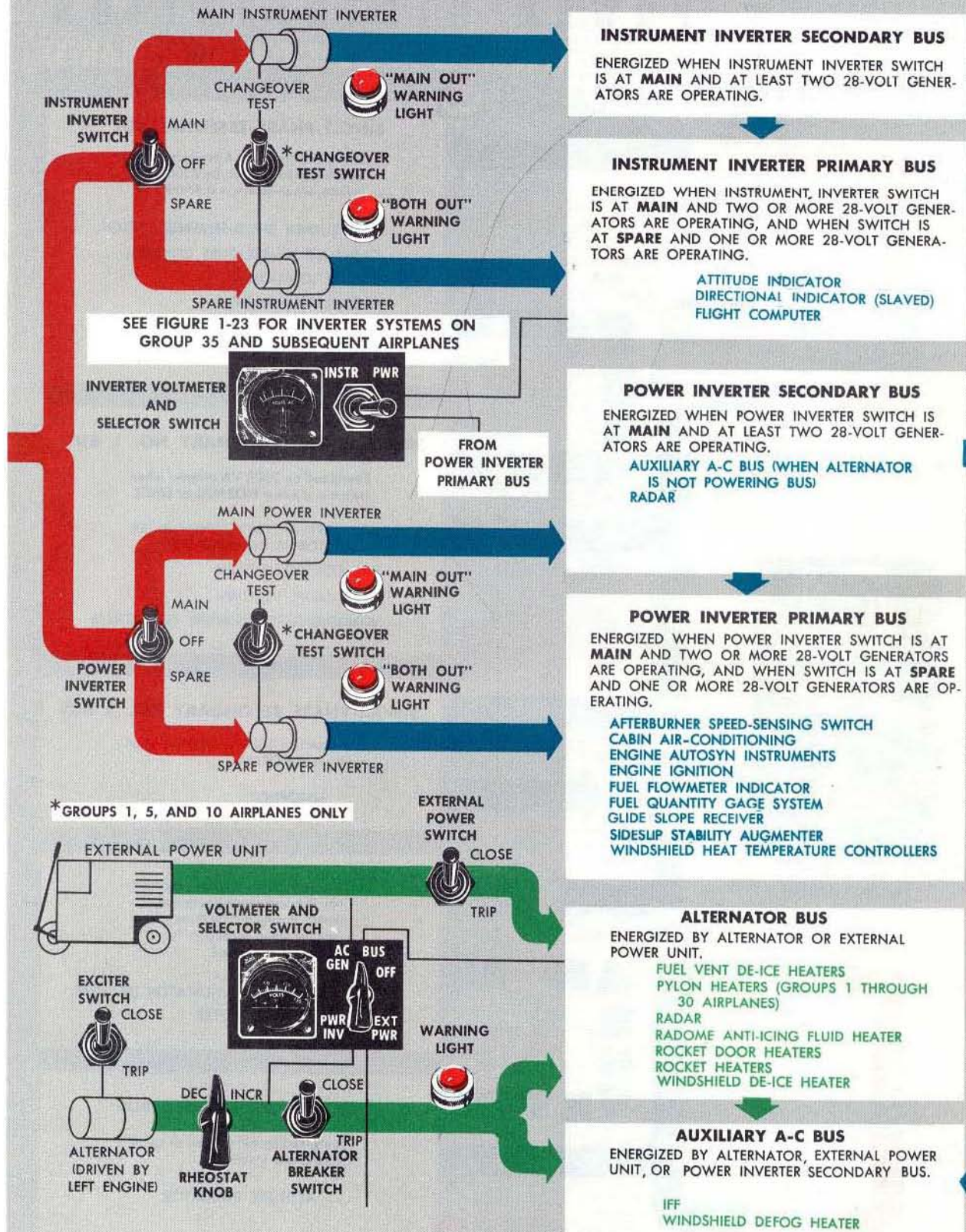


Figure 1-22.



D-23(2)

A-C INVERTER POWER DISTRIBUTION

(GROUP 35 AND SUBSEQUENT AIRPLANES)

NOTE

- Normal flow is shown with **SOLID** lines; emergency flow is shown with **BROKEN** lines.
- See Figure 1-22 for alternator a-c system.

SEE FIGURE 1-22 FOR GROUPS 1 THROUGH 30 AIRPLANES

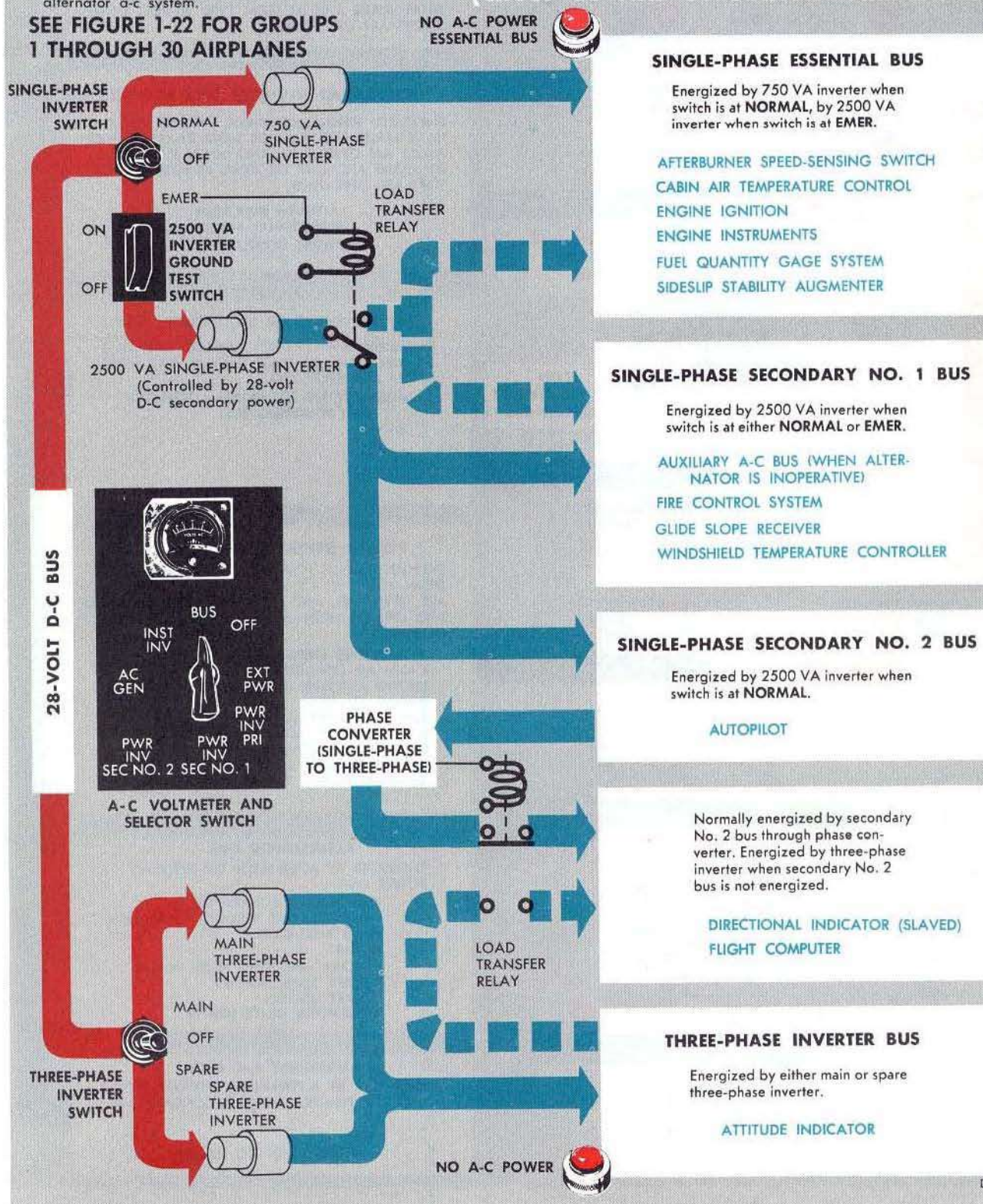


Figure 1-23.

D-23(3)

28-Volt D-C Generator Switches.

For each 28-volt d-c generator there is a guarded generator switch (figure 1-24) located on the 28-volt d-c control panel. The function of these switches is to connect the corresponding generator to the 28-volt d-c primary bus and to reset the overvoltage relay after an overvoltage condition has occurred. The switch positions are ON, OFF, and RESET. The switch is spring-loaded to OFF from the RESET position. Placing the switch at ON connects the generator to the primary bus; at OFF, it disconnects the generator from the bus. The RESET position is used as follows: If the voltage of a generator becomes excessive, an overvoltage relay opens the generator field circuit and causes generator voltage to drop to zero. As the voltage drops, a reverse-current cutout relay disconnects the generator from the primary bus. To return the generator to service, the switch must be placed momentarily at RESET. A circuit is then completed to the generator field, and generator voltage builds up to normal. Then the switch can be placed at ON to complete the circuit between the generator and the 28-volt d-c bus. If the overvoltage condition persists (as indicated by the warning light again coming on), voltage can be reduced to the correct value by first placing the generator switch at OFF, then turning the voltage regulator rheostat knob toward DEC (counterclockwise). Next, the generator switch must be placed momentarily at RESET, then returned to OFF. With the switch at OFF, the voltage regulator rheostat knob should be adjusted so that the voltmeter reads 28 volts. Then the generator switch can be placed at ON to put the generator back into service.

28-Volt D-C Generator Warning Lights.

On some airplanes, each generator has a 28-volt d-c overvoltage warning light (figure 1-24) located on the 28-volt d-c control panel. These lights are marked "Overvoltage Warning." The function of the lights is to warn the pilot that the corresponding generator has been automatically disconnected from the 28-volt bus due to an overvoltage condition. On other airplanes, there is for each generator a 28-volt d-c generator-off warning light (figure 1-24) located on the 28-volt d-c control panel. These lights are marked "Gen. Off." The function of these lights is to warn the pilot when the corresponding generator is disconnected from the 28-volt bus. Each light, powered by 28-volt dc through a connection with the generator reverse-current cutout relay, illuminates when the 28-volt d-c bus is energized and the generator is out of service (not connected to the primary bus). Specifically, the light will come on under the following conditions: before starting engines when the battery switch is placed at ON or an external source of d-c power is applied to the airplane, when the engines are operating but the generator switch is at OFF, or if the generator has been automatically disconnected because of an overvoltage condition.

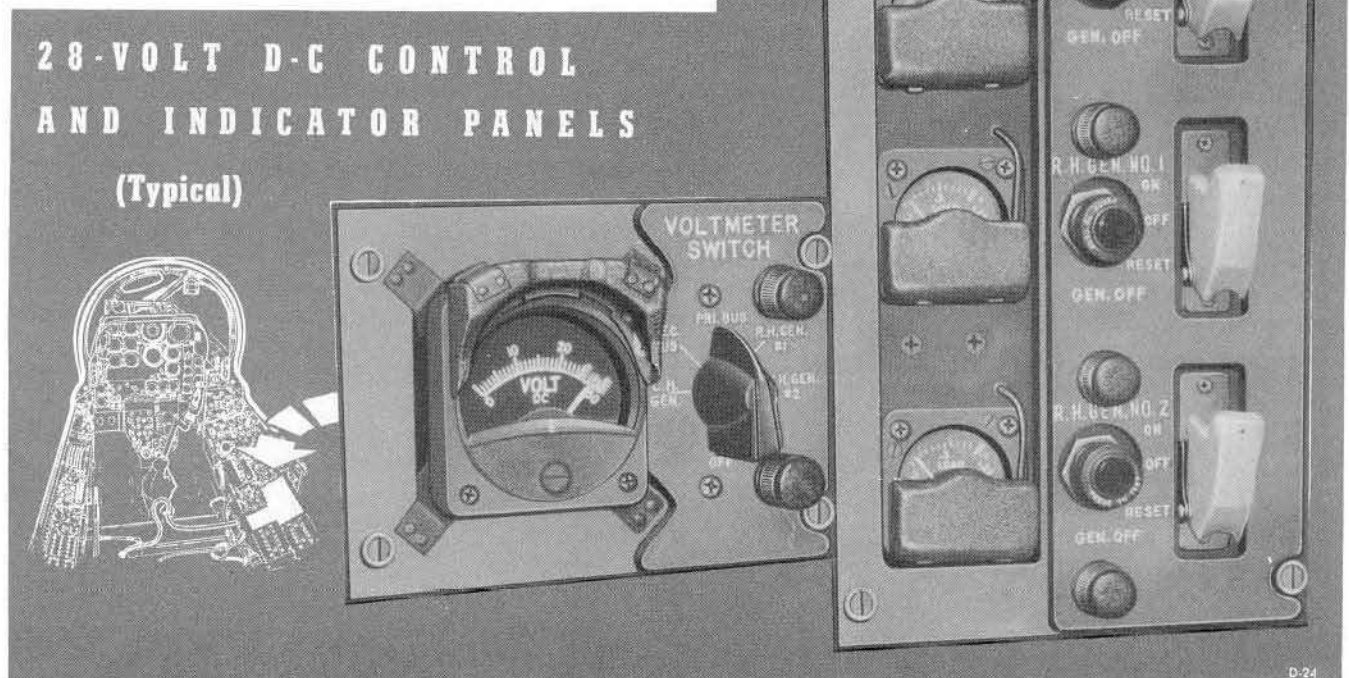
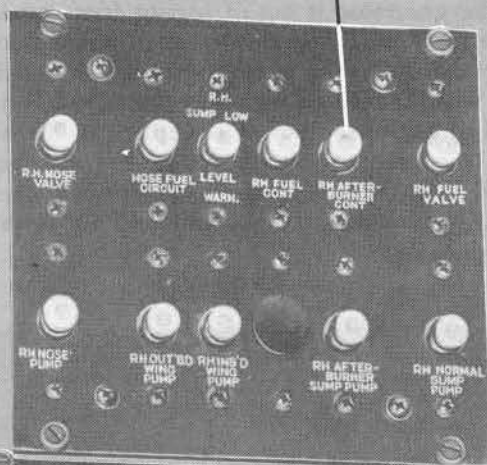


Figure 1-24.

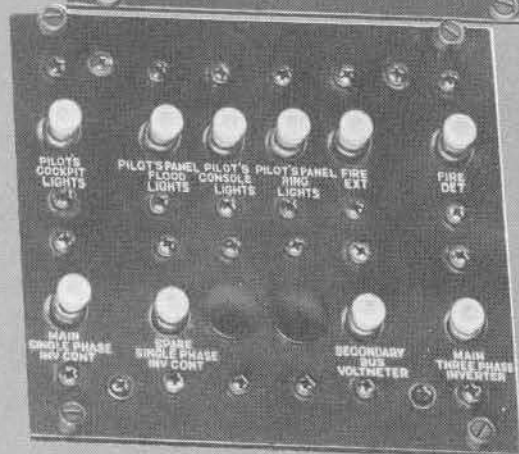
PILOT'S CIRCUIT BREAKER PANELS (Typical)

TOGGLE SWITCH
(SOME AIRPLANES)

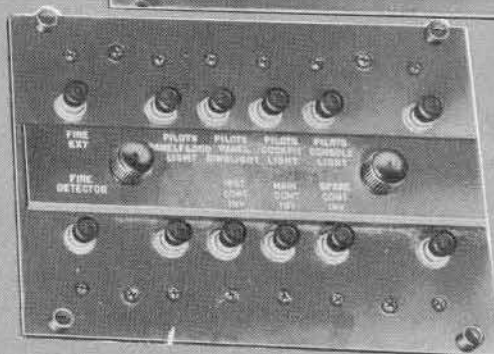
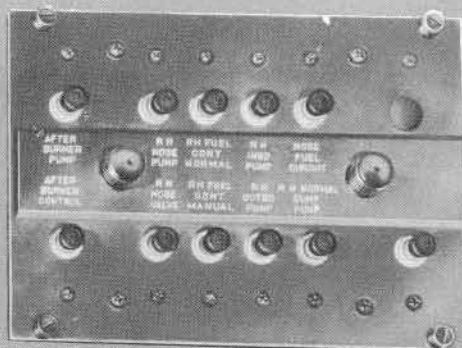


Pilot's Aft Right Vertical Panel

(GROUP 35 AND SUBSEQUENT AIRPLANES)



(GROUP 35 AND SUBSEQUENT AIRPLANES)

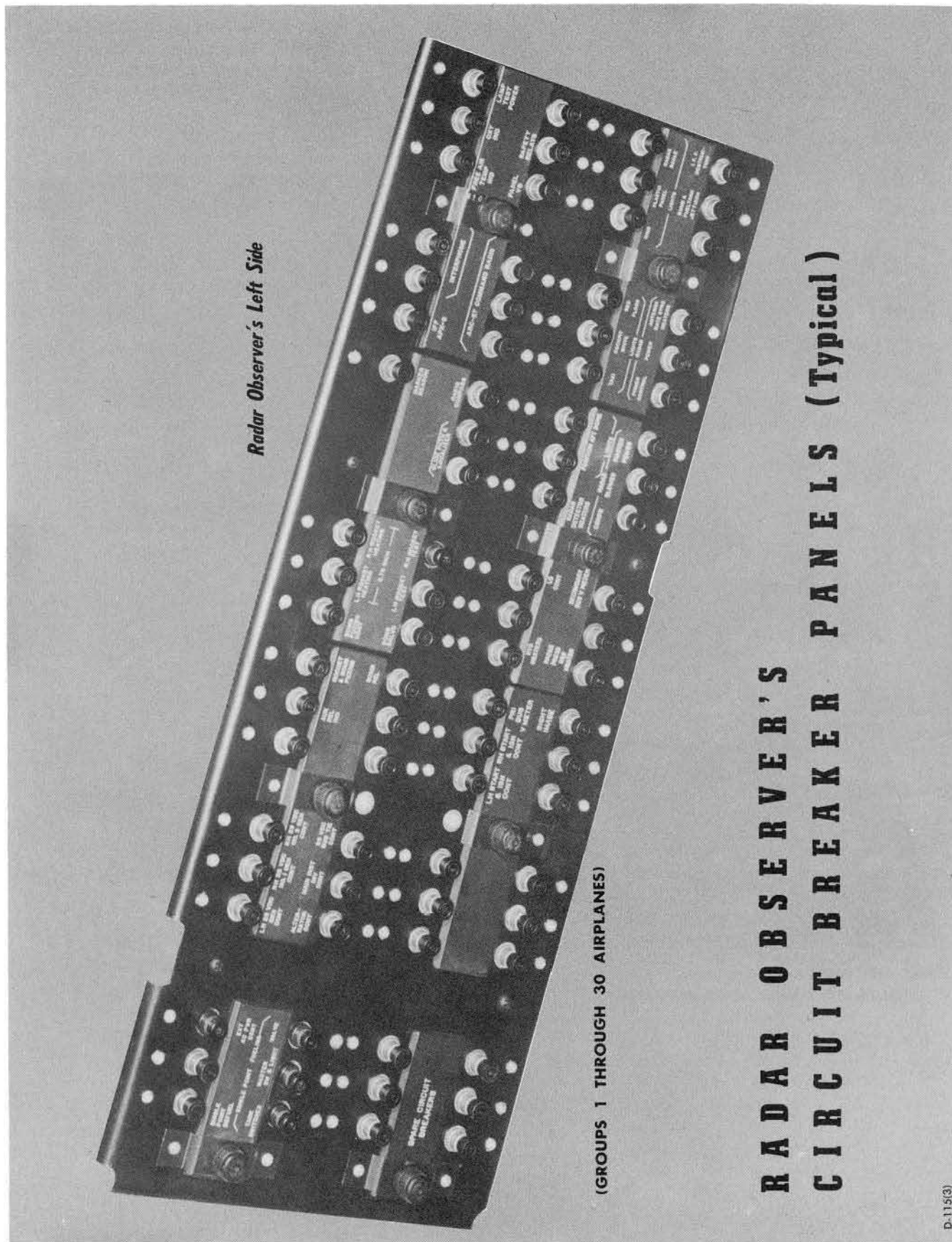


(GROUPS 1 THROUGH 30 AIRPLANES)

Pilot's Right Console



Figure 1-25 (Sheet 2 of 4 Sheets).



Radar Observer's Left Side

(GROUPS 1 THROUGH 30 AIRPLANES)

RADAR OBSERVER'S CIRCUIT BREAKER PANELS (Typical)

D-115(3)

Figure 1-25 (Sheet 3 of 4 Sheets).

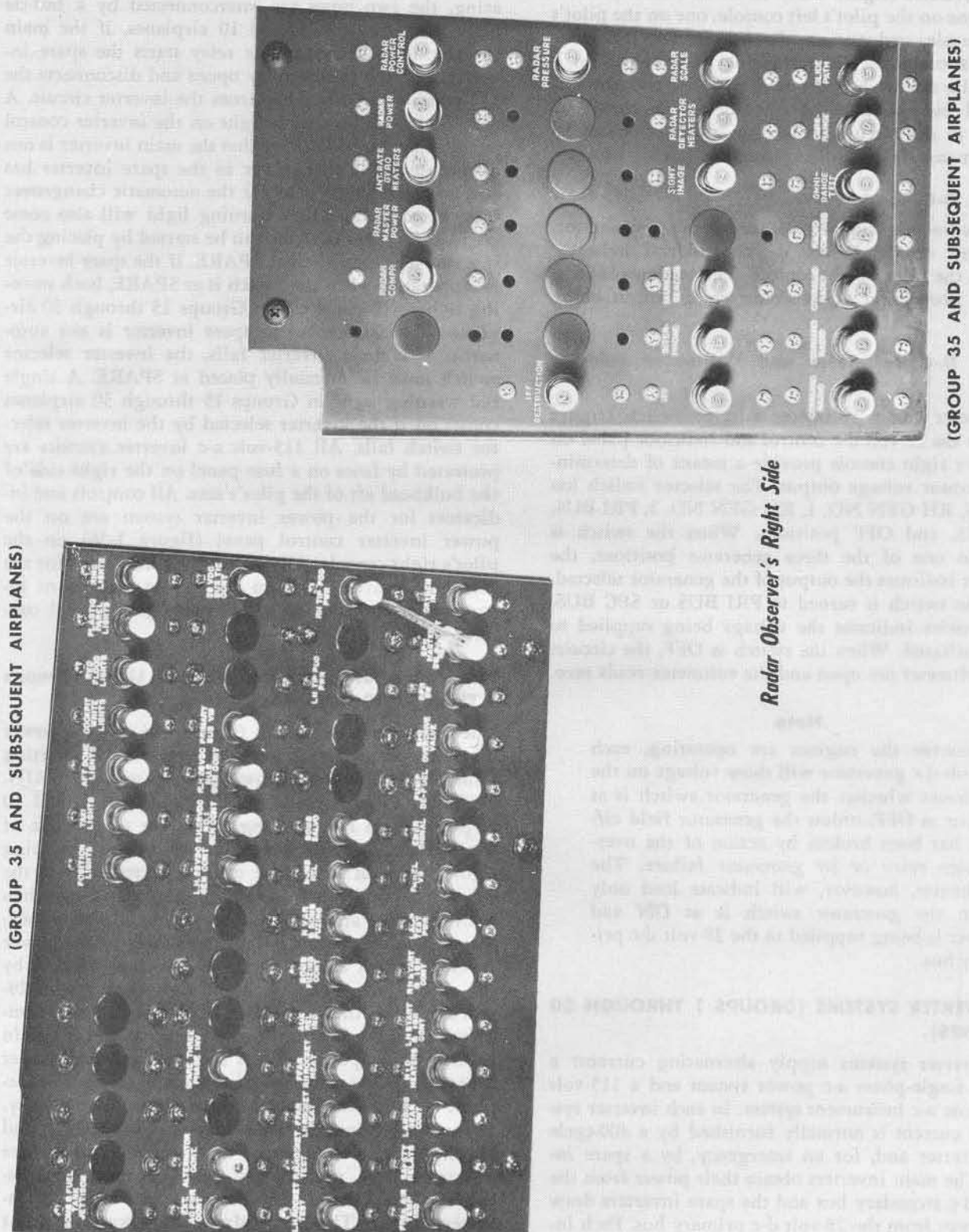


Figure 1-25 (Sheet 4 of 4 Sheets).

28-Volt D-C Circuit Breakers.

Most of the 28-volt d-c electrical circuits (all except a few emergency circuits) are protected by push-pull circuit breakers (figure 1-25) on three circuit breaker panels: one on the pilot's left console, one on the pilot's right console, and one on the left side of the radar observer's cockpit. When there is an overload in a circuit, the circuit breaker will pop out and the circuit will be opened. The circuit can be closed by pushing in the circuit breaker, or the circuit can be opened manually by pulling out the circuit breaker.

28-Volt D-C Loadmeters.

Three loadmeters (figure 1-24), one for each generator, are located on the 28-volt d-c control and indicator panel on the pilot's right console. The loadmeters indicate the proportion of generator rated output being used.

28-Volt D-C Voltmeter and Voltmeter Selector Switch.

A voltmeter and a voltmeter selector switch (figure 1-24), on the 28-volt d-c control and indicator panel on the pilot's right console provide a means of determining generator voltage output. The selector switch has LH GEN, RH GEN NO. 1, RH GEN NO. 2, PRI BUS, SEC BUS, and OFF positions. When the switch is turned to one of the three generator positions, the voltmeter indicates the output of the generator selected. When the switch is turned to PRI BUS or SEC BUS, the voltmeter indicates the voltage being supplied to the bus selected. When the switch is OFF, the circuits to the voltmeter are open and the voltmeter reads zero.

Note

Whenever the engines are operating, each 28-volt d-c generator will show voltage on the voltmeter whether the generator switch is at ON or at OFF, unless the generator field circuit has been broken by action of the over-voltage relay or by generator failure. The loadmeter, however, will indicate load only when the generator switch is at ON and power is being supplied to the 28-volt d-c primary bus.

A-C INVERTER SYSTEMS (GROUPS 1 THROUGH 30 AIRPLANES).

Two inverter systems supply alternating current: a 115-volt single-phase a-c power system and a 115-volt three-phase a-c instrument system. In each inverter system, the current is normally furnished by a 400-cycle main inverter and, for an emergency, by a spare inverter. The main inverters obtain their power from the 28-volt d-c secondary bus and the spare inverters draw their power from the 28-volt d-c primary bus. Each inverter system has a primary bus which supplies power to equipment essential for flight and a secondary bus which supplies power to the equipment necessary for

tactical missions. (See figure 1-22.) The main inverters in each system supply power to the primary and secondary buses; the spare inverters supply power only to the primary buses. When the main inverters are operating, the two buses are interconnected by a bus-tie relay. In Groups 1, 5, and 10 airplanes, if the main inverter fails, a changeover relay starts the spare inverter, and the bus-tie relay opens and disconnects the 115-volt a-c secondary bus from the inverter circuit. A red "Main Out" warning light on the inverter control panel comes on to indicate that the main inverter is not operating and a changeover to the spare inverter has automatically taken place. If the automatic changeover fails, a red "Both Out" warning light will also come on, and the spare inverter can be started by placing the inverter selector switch at SPARE. If the spare inverter is inoperative when the switch is at SPARE, both warning lights will come on. In Groups 15 through 30 airplanes, the changeover to spare inverter is not automatic. If a main inverter fails, the inverter selector switch must be manually placed at SPARE. A single red warning light in Groups 15 through 30 airplanes comes on if the inverter selected by the inverter selector switch fails. All 115-volt a-c inverter circuits are protected by fuses on a fuse panel on the right side of the bulkhead aft of the pilot's seat. All controls and indicators for the power inverter system are on the power inverter control panel (figure 1-26) on the pilot's right console. All controls and indicators for the instrument inverter system are on the instrument inverter control panel on the pilot's right vertical console.

Power Inverter Switch and Warning Lights (Groups 1 Through 30 Airplanes).

The power inverter switch (figure 1-26) on the power inverter control panel provides a means of selecting either the main or spare power inverter and has MAIN, OFF, and SPARE positions. On Groups 1, 5, and 10 airplanes, two red warning lights are to the left of the switch. One red dimming "Main Out" warning light comes on when the main inverter is out; the other red "Both Out" warning light comes on when both inverters are out. On Groups 15 through 30 airplanes, one red warning light to the left of the power inverter switch comes on if the inverter selected by the switch fails. The switch and lights operate on 28-volt dc. When the switch is at MAIN, a circuit is completed from the 28-volt d-c secondary bus and the main inverter will operate. When the main power inverter is operating, the primary and secondary 115-volt single-phase a-c buses are interconnected by the bus-tie relay. If the main power inverter fails on Groups 1, 5, and 10 airplanes, a changeover relay turns on the spare power inverter, and the bus-tie relay opens and disconnects the 115-volt a-c secondary bus from the inverter circuit. The red "Main Out" warning light comes on to indicate that the main power inverter is not operating and a changeover to the spare power inverter has taken place. The equipment essential to

flight (powered by the primary bus) continues to operate and the equipment not essential to flight (powered by the secondary bus) is inoperable. If the automatic changeover fails, both the "Main Out" and the "Both Out" warning lights will come on; the spare power inverter can be started by placing the switch at SPARE. If the spare inverter is inoperative when the switch is at SPARE, both warning lights will come on. If the main power inverter fails on Groups 15 through 30 airplanes, the single red warning light comes on and the switch must be placed at SPARE. When the switch is placed at SPARE, the circuit is completed from the 28-volt d-c primary bus to the spare inverter and the bus-tie relay opens and disconnects the 115-volt a-c secondary bus from the inverter circuit. When the switch is at OFF, the circuits between the inverters and the 28-volt d-c buses are broken.

Power Inverter Changeover Test Switch (Groups 1, 5, and 10 Airplanes).

A changeover test switch (figure 1-26) on the power inverter control panel is provided to check the operation of the automatic changeover system for the single-phase inverters. When the main inverter has been on

for 70 seconds or more, the spring-loaded changeover test switch can be held at TEST. In 5 seconds or more, the changeover relay will shift the load from the main to spare inverter and the "Main Out" light will come on. After the light comes on, the switch must be held to TEST for approximately 12 seconds more for the system to cycle back to the main inverter and the "Main Out" light to go out. If the switch is released after the system cycles to the spare inverter, the main inverter will stay out and the spare will continue to operate. To complete the cycle and return the main inverter to operation, the switch must be held again to TEST until the "Main Out" light goes out; then the switch must be released before the cycle repeats itself. If the inverters are cold, a longer time is required for the changeover cycle to be completed.

CAUTION

Do not hold the changeover test switch in the TEST position long enough to allow the inverters to complete more than one cycle from main to spare, and back to main again, as the main inverter may be damaged.

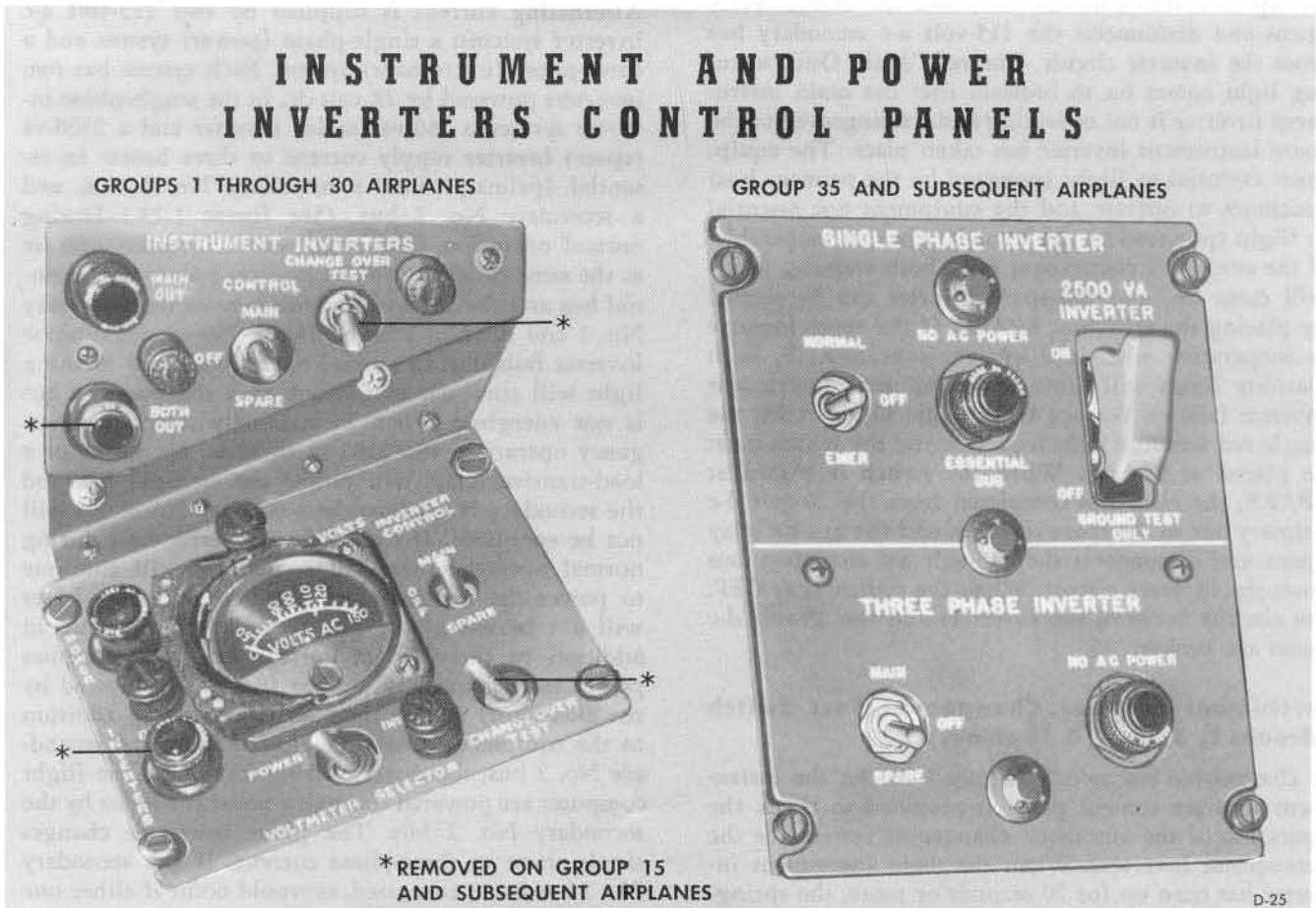


Figure 1-26.

Note

The test switch should be released when the "Main Out" warning light goes out so that the main inverter will remain in operation.

Instrument Inverter Switch and Warning Lights (Groups 1 Through 30 Airplanes).

The instrument inverter switch (figure 1-26) on the instrument inverter control panel provides a means of selecting either the main or the spare instrument inverter and has MAIN, OFF, and SPARE positions. On Groups 1, 5, and 10 airplanes, two red warning lights are to the left of the switch. One red dimming "Main Out" warning light comes on when the main inverter is out; the other red nondimming "Both Out" warning light comes on when both inverters are out. On Groups 15 through 30 airplanes, one red warning light next to the instrument inverter switch comes on if the inverter selected by the switch fails. The switch and lights operate on 28-volt dc. When the switch is at MAIN, a circuit is completed from the 28-volt d-c secondary bus and the main instrument inverter will operate. When the main instrument inverter is operating, the primary and secondary 115-volt single-phase a-c buses are interconnected by the bus-tie relay. If the main instrument inverter fails on Groups 1, 5, and 10 airplanes, a changeover relay automatically turns on the spare instrument inverter, and the bus-tie relay opens and disconnects the 115-volt a-c secondary bus from the inverter circuit. The red "Main Out" warning light comes on to indicate that the main instrument inverter is not operating and a changeover to the spare instrument inverter has taken place. The equipment essential to flight (powered by the primary bus) continues to operate and the equipment not essential to flight (powered by the secondary bus) is inoperable. If the automatic changeover fails, both warning lights will come on, and the spare inverter can be started by placing the switch at SPARE. If the spare inverter is inoperative when the switch is at SPARE, both warning lights will come on. If the main instrument inverter fails on Groups 15 through 30 airplanes, the single red warning light comes on and the switch must be placed at SPARE. When the switch is placed at SPARE, the circuit is completed from the 28-volt d-c primary bus to the spare inverter, and the bus-tie relay opens and disconnects the 115-volt a-c secondary bus from the inverter circuit. When the switch is at OFF, the circuits between the inverters and the 28-volt d-c buses are broken.

Instrument Inverter Changeover Test Switch (Groups 1, 5, and 10 Airplanes).

A changeover test switch (figure 1-26) on the instrument inverter control panel is provided to check the operation of the automatic changeover system for the three-phase inverters. When the main instrument inverter has been on for 70 seconds or more, the spring-loaded changeover test switch can be held at TEST.

Within 8 seconds, the changeover system cycles from main to spare inverter. The "Main Out" light comes on and stays on until the switch is released from the TEST position. When the switch is released, the changeover system switches back to the main inverter and the "Main Out" light goes out. If the spare inverter fails to operate when the changeover test is made, both the "Main Out" and the "Both Out" lights will come on.

Note

The instrument inverters will cycle from main to spare only once regardless of how long the changeover test switch is held at TEST.

Inverter Voltmeter and Selector Switch (Groups 1 Through 30 Airplanes).

A voltmeter and a voltmeter selector switch (figure 1-26) are on the power inverter control panel. When the switch is at POWER or INSTR, the circuit is completed from the voltmeter to the operating inverter of the corresponding system and the voltage is indicated on the voltmeter.

A-C INVERTER SYSTEMS (GROUPS 35 AND SUBSEQUENT AIRPLANES).

Alternating current is supplied by two 115-volt a-c inverter systems: a single-phase (power) system and a three-phase (instrument) system. Each system has two inverters powered by 28-volt dc. In the single-phase inverter system, a 750-va (main) inverter and a 2500-va (spare) inverter supply current to three buses: an essential (primary) bus, a secondary No. 1 bus, and a secondary No. 2 bus. (See figure 1-23.) During normal operation, both single-phase inverters operate at the same time; the 750-va inverter powers the essential bus and the 2500-va inverter powers the secondary No. 1 and the No. 2 buses. If the 750-va single-phase inverter fails during normal operation, a red warning light will come on to indicate that the essential bus is not energized. Then by manually selecting emergency operation, the 2500-va inverter, by means of a load-transfer relay, will power the essential bus and the secondary No. 1 bus; the secondary No. 2 bus will not be energized. If the 2500-va inverter fails during normal operation, the 750-va inverter will continue to power the essential bus; the two secondary buses will not be energized. The secondary No. 1 bus, in addition to carrying its normal load, also supplies power to the auxiliary a-c bus (normally powered by the alternator) in case the alternator fails. In addition to the equipment operating directly from the secondary No. 2 bus, the directional indicator and the flight computer are powered through a phase converter by the secondary No. 2 bus. The phase converter changes single-phase to three-phase current. If the secondary No. 2 bus is not energized, as would occur if either one or both of the single-phase inverters fail, a load-transfer

relay will automatically shift the load of the Directional indicator and the flight computer to the three-phase (instrument) inverter system. In the three-phase (instrument) inverter system, both main and spare inverters are rated at 500-va. Only one inverter (main or spare) operates at a time. Normally, only the attitude indicator is powered by the three-phase inverter system; however, if the secondary No. 2 bus of the single-phase inverter system is not energized, then the three-phase system will automatically supply power to the directional indicator and the flight computer. Operation of either main or spare three-phase inverter is manually selected. A red warning light comes on if the selected three-phase inverter fails. All controls and indicators, except the a-c voltmeter and voltmeter selector switch, for both the single-phase and three-phase inverter systems are mounted on one inverter control panel (figure 1-26) located on the pilot's right console. The voltmeter and voltmeter selector switch, which serve both inverter systems and alternator system, are located in the radar observer's cockpit on the alternator control panel. All equipment powered by the single-phase inverter system is protected by circuit breakers located on a panel mounted on the right side of the bulkhead aft of the pilot's seat. All four inverters are powered by the primary 28-volt d-c bus; however, the control circuit for the 2500-va single-phase inverter receives its power from the secondary 28-volt d-c bus (energized when two or more 28-volt d-c generators are operating).

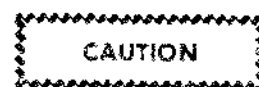
Single-Phase (Power) Inverter Switch (Group 35 and Subsequent Airplanes).

A 28-volt d-c switch (figure 1-26) on the inverter control panel provides a means of selecting normal or emergency operation of the single-phase inverter system. The switch has three positions: NORMAL, OFF, and EMER. When the switch is placed at NORMAL, a circuit is completed from the 28-volt d-c bus and both the 750-va (main) and 2500-va (spare) single-phase inverters operate: the 750-va inverter supplies power to the essential bus and the 2500-va inverter supplies power to the secondary No. 1 and No. 2 buses. When the switch is placed at EMER, the 2500-va inverter supplies power to the essential bus and the No. 1 secondary bus; the No. 2 secondary bus will not be energized and the 750-va inverter will not operate. The EMER position should be used only when the 750-va inverter fails. If emergency operation is selected when the 2500-va inverter fails, all single-phase buses will be without power. If both the 750-va and the 2500-va inverters fail, as would be indicated by the "Essential Bus" warning light burning when the switch is placed at both NORMAL and EMER, the switch should be placed at OFF. When the switch is placed at OFF, the control circuits from the 28-volt d-c primary bus to the single-phase inverters are broken. Both single-phase inverters and the control circuit for the 750-va inverter receive their power from the 28-volt d-c primary bus; the control circuit for the

2500-va inverter receives its power from the 28-volt d-c secondary bus (energized when two or more 28-volt d-c generators are operating).

Single-Phase 2500-VA Inverter Ground Test Switch (Groups 35 and Subsequent Airplanes).

A 28-volt d-c guarded switch (figure 1-26) on the inverter control panel provides a means of operating the single-phase 750-va (main) inverter independently of the 2500-va (spare) inverter for ground testing purposes. The switch is marked "2500VA Inverter—Ground Test Only" and has ON and OFF positions. When the switch is at ON (guard down), with the single-phase inverter switch at NORMAL, both single-phase inverters operate. When the switch is at OFF (guard raised), with the inverter switch at NORMAL, only the 750-va inverter will operate. The 2500-va inverter can be operated independently of the 750-va inverter by placing the inverter switch at EMER.



The ground test switch is for ground testing purposes only. Do not use it in flight. If the switch is placed at OFF during normal operation, all equipment powered by the secondary No. 1 and No. 2 buses will become inoperative.

Three-Phase (Instrument) Inverter Switch (Groups 35 and Subsequent Airplanes).

A 28-volt d-c switch (figure 1-26) on the inverter control panel is used to select either the main or spare three-phase inverter. The switch has three positions: MAIN, SPARE, and OFF. When the switch is placed at MAIN or SPARE, a circuit is completed from the 28-volt d-c bus to the corresponding inverter. When the switch is at OFF, both main and spare inverters are inoperative. A red warning light burns if the selected inverter (main or spare) is not operating, or if the inverter switch is at OFF.

Single-Phase (Power) Inverter Warning Light (Group 35 and Subsequent Airplanes).

A red warning light (figure 1-26) on the single-phase portion of the inverter control panel indicates when the essential bus of the single-phase inverter system is not energized. The light is marked "No AC Power—Essential Bus" and operates on 28-volt dc. If the light comes on while the single-phase inverter switch is at NORMAL, the switch can be moved to EMER so that the 2500-va inverter will supply power to the essential bus. As soon as the essential bus receives power, the light will go out. The light will burn when the switch is at OFF.

Three-Phase (Instrument) Inverter Warning Light (Groups 35 and Subsequent Airplanes).

A red warning light (figure 1-26), marked "No AC Power" and located on the three-phase portion of the inverter control panel, comes on if the selected (main or spare) three-phase inverter is inoperative or if the inverter switch is at OFF. The light operates on 28-volt dc.

A-C Voltmeter and Selector Switch (Group 35 and Subsequent Airplanes).

On Group 35 and subsequent airplanes, only one voltmeter is provided for both the inverter systems and

the alternator system. This voltmeter, with its selector switch (figure 1-26), is located on the radar observer's alternator control panel. For a complete discussion on the voltmeter and selector switch, see paragraph entitled A-C Voltmeter and Selector Switch (Group 35 and Subsequent Airplanes) included in subsequent discussion on the a-c alternator system, this section.

A-C ALTERNATOR SYSTEM.

A variable-frequency alternator, driven by the left engine, supplies three-phase 115-volt ac to two buses: the alternator bus and the auxiliary a-c bus. (See figure 1-22.) An exciter switch turns on the

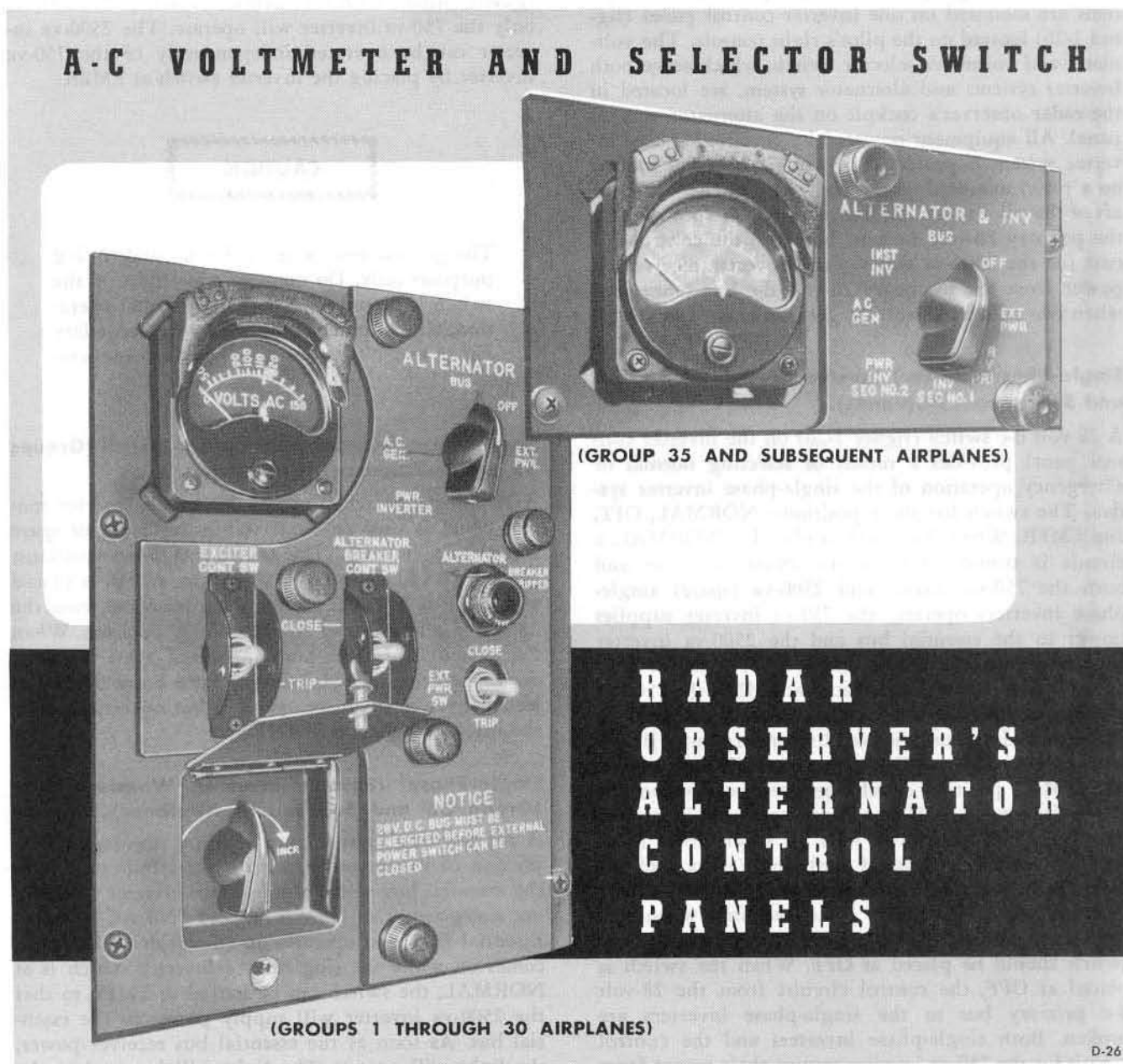


Figure 1-27.

alternator and an alternator circuit breaker switch connects the alternator output to the two buses. Both switches must be placed at CLOSE momentarily to obtain any alternator output. In addition, on Groups 1 through 50 airplanes, a throttle limit switch actuated by the left throttle linkage prevents closing the alternator exciter circuit until the left throttle is advanced past the 60% rpm position, and turns off the alternator when the left throttle is retarded below the 48% rpm position. If the alternator fails, an auxiliary bus-tie relay connects the auxiliary a-c bus to a single-phase inverter bus and to the main power inverter bus on Groups 1 through 30 airplanes, or to the secondary No. 1 inverter bus on Group 35 and subsequent airplanes. The external power receptacle for the alternator system is the bottom receptacle on the right engine air intake duct. An external power circuit breaker connects the external power source to the alternator and auxiliary a-c buses when the external power switch is held momentarily at CLOSE. Before the external power switch can be closed, the 28-volt d-c external power must be connected. Tripping the external power switch or closing the alternator circuit breaker switch trips the external power circuit breaker. A voltmeter and a selector switch permit voltage readings of the external power, the alternator buses, the alternator a-c generator, the main power inverter on Groups 1 through 30 airplanes, and all inverter buses on Group 35 and subsequent airplanes. A guarded voltage rheostat can be used to adjust the voltage output of the alternator. A complete set of controls for the alternator is on the alternator control panel on the left side of the radar observer's cockpit. The pilot has only an exciter switch, an alternator circuit breaker switch, and a red indicator light on his alternator control panel. The pilot's switches and indicator light parallel those of the radar observer. The red indicator light comes on to warn that the alternator circuit breaker is in the tripped position. Fuses for the alternator system are in the forward electrical equipment section.

Alternator External Power Switch.

The three-position external power switch (figure 1-27) on the radar observer's alternator control panel controls the external power circuit breaker. The switch is spring-loaded to NEUTRAL from the CLOSE and TRIP positions. After a 115-volt 400-cycle a-c external power source is connected to the external power receptacle, the external power switch can be held momentarily at CLOSE to close the circuit breaker connecting the external power source to the distribution bus. Holding the switch momentarily at TRIP discontinues external a-c power to the distribution bus. When the alternator circuit breaker switch is held to CLOSE, it automatically trips the external power circuit breaker.

CAUTION

Operation of more than one alternator switch at a time will result in damage to the alternator control circuit.

Note

Before the external power switch can be closed, 28-volt d-c external power must be connected.

Alternator Exciter Switch.

A three-position exciter switch (figure 1-12) on the pilot's alternator control panel and a similar switch on the radar observer's alternator control panel (figure 1-27) control 28-volt d-c circuits to the alternator exciter relay and provide a means for either crew-member to turn the alternator on and off. These switches are spring-loaded to NEUTRAL from the CLOSE and TRIP positions. When either switch is held momentarily at CLOSE (and the left throttle is advanced past the 60% rpm position), a circuit is completed from the 28-volt d-c bus to the exciter relay, which in turn closes and turns on the alternator. When the switch is held momentarily to TRIP, the circuit from the 28-volt d-c bus to the exciter relay is broken; the relay opens and cuts off alternator output.

Note

On Groups 1 through 50 airplanes, a limit switch in the left engine throttle quadrant prevents closing the alternator exciter circuit until the left throttle is advanced past the 60% rpm position. The limit switch also cuts off alternator output when the left throttle is retarded below the 48% rpm position.

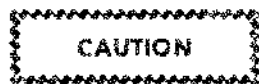
CAUTION

Operation of more than one alternator switch at a time will result in damage to the alternator control circuit.

Alternator Circuit Breaker Switch and Indicator Light.

A three-position circuit breaker switch (figure 1-12) on the pilot's alternator control panel and the radar observer's control panel (figure 1-27) closes or trips the alternator circuit breaker. The switch is spring-loaded to NEUTRAL from the CLOSE and TRIP positions. Holding the switch momentarily in the CLOSE position closes the circuit breaker connecting the alternator to the distribution bus and automatically trips the external power circuit breaker. Holding

the switch momentarily in the TRIP position opens the circuit breaker, discontinuing alternator output to the distribution bus. The red indicator light to the right of the circuit breaker switch in each cockpit comes on when the alternator circuit breaker is in the tripped position.



Operation of more than one alternator switch at a time will result in damage to the alternator control circuit.

Alternator Voltage Rheostat.

A guarded voltage rheostat (figure 1-27) on the radar observer's alternator control panel can be used to adjust the voltage output of the alternator.

A-C Voltmeter and Selector Switch (Groups 1 Through 30 Airplanes).

A voltmeter and a five-position selector switch (figure 1-27) on the radar observer's alternator control panel permit various voltage readings. When the switch is at the EXT. PWR. position, the voltmeter indicates external power voltage before the external power switch is closed. When the switch is at the BUS position, the voltmeter indicates the voltage at the distribution bus. When the switch is at the A.C. GEN. position, the voltmeter indicates the voltage output of the alternator. When the switch is at the PWR. INVERTER position, the voltmeter indicates voltage output of the main power inverter.

A-C Voltmeter and Selector Switch (Group 35 and Subsequent Airplanes).

A voltmeter and selector switch (figure 1-27), located on the radar observer's alternator control panel, are used to check the voltage of all a-c power systems. The rotary selector switch has eight positions: OFF, EXT PWR, PWR INV PRI, PWR INV SEC NO. 1, PWR INV SEC NO. 2, AC GEN, INST INV, and BUS. When the switch is at EXT PWR, the voltmeter indicates external a-c power voltage before the external power switch is closed. When the switch is at PWR INV PRI, PWR INV SEC NO. 1, or PWR INV SEC NO. 2, the voltmeter indicates the voltage of the corresponding single-phase bus. When the switch is at AC GEN, the voltmeter indicates the voltage output of the alternator. When the switch is at INST INV, the voltage indicated is that of the selected three-phase inverter (main or spare). When the switch is at BUS, the alternator bus voltage is indicated.

HYDRAULIC POWER SUPPLY SYSTEM.

The complete hydraulic power installation includes a left system and right system, both powered by engine-driven pumps, and on Groups 1 through 35 airplanes,

an emergency wing flap system. (See figures 1-28 and 1-32.) In addition, some airplanes have an emergency flight control system consisting of an electrically driven pump tied into the right hydraulic system. Airplanes not having the emergency pump are equipped with a supplemental electrically driven hydraulic pump tied into the left hydraulic system. No interflow can occur between the left and right systems. The left and right systems operate at 3000 psi, the emergency flight control system at 1500 psi, and the supplemental hydraulic pump at 2500 psi. Each primary flight control has dual actuating cylinders; one powered by the left system and one powered by the right system. If either the left or right system fails, the remaining system provides adequate but limited flight control. The emergency flight control system provides further limited control if both the left and right systems fail. One pressurized hydraulic reservoir for the left system and one for the right system are in the forward fuselage section. The reservoirs are pressurized to prevent the fluid from foaming at altitude and to maintain a positive pressure on the inlet side of the engine-driven pumps. During engine starts, a purge valve, one in each system, bypasses hydraulic fluid from the pump back to the reservoir to reduce the load on the starter. After the engine starts, the pump puts out more fluid than the purge valve can bypass. The increase of pressure in the valve overcomes a spring tension and forces a piston over the return line to close the valve. System pressure then builds up to 3000 psi. During cold weather, for ground operation only, the hydraulic fluid in the left and right systems is maintained automatically at operating temperature. The weight of the airplane on the landing gear energizes a circuit to a thermoswitch. When the fluid temperature drops below a predetermined value, the thermoswitch actuates an electric shutoff valve and the fluid is routed through a restrictor which raises the temperature of the fluid until the correct temperature is obtained. See figures 1-28, 1-29, 1-32, 1-35, 1-38, and 1-39 for hydraulically operated equipment. Refer to figure 1-45 for hydraulic fluid specification.

LEFT HYDRAULIC SYSTEM.

Operating pressure for the left system comes from an engine-driven piston-type hydraulic pump on the left engine. This system powers one actuating cylinder on each flight control surface, the landing gear, main gear inboard doors, wheel brakes, wing flaps, speed brakes, and the nose wheel steering system. The left system includes a pressurized reservoir in the left side of the forward fuselage section, a brake accumulator in the nose gear wheel well, a handpump and two selector valves in the radar observer's cockpit, and, on Groups 1 through 35 airplanes, an emergency wing flap system. The handpump is ordinarily used to operate the hydraulic engine hoist system. In an emergency the radar observer can recharge the brake hydraulic accumulator by placing the two selector valves at the proper placard positions and then actuating the pump

handle. On some airplanes, the emergency flight control system has been eliminated from the right hydraulic system and an increased capacity hydraulic pump, energized by the 28-volt d-c primary bus, has been installed in the left hydraulic system. This modification will be found only on those airplanes equipped with nose wheel steering. Whether or not the hydraulic system modification has been accomplished is most readily determined by checking the emergency flight control panel in the pilot's cockpit. If the emergency flight control switch and indicator light have been removed, the airplane has been modified. The supplemental pump is started in three different ways. It starts automatically either in flight or on the ground whenever brake accumulator pressure drops below 1150—800 psi. A landing gear lever switch also starts the pump automatically when the landing gear lever is moved to the DOWN position in flight, to supply an additional volume of hydraulic flow to lower the gear. A strut switch cuts out the landing gear lever switch to prevent the pump operating while the airplane's weight is on the gear. While in flight or while taxiing, the pump can be operated whenever additional left hydraulic system flow is desired by depressing the nose wheel steering button. The steering and brake systems have first priority on supplemental pump flow so that only the surplus flow enters the main left hydraulic system. This provides adequate flow on the ground for braking and steering regardless of other hydraulic system functions, even with the left engine inoperative. Since braking and steering are not used in the air, all the flow enters the left main system when the nose wheel steering button is depressed or the gear lowered.

Note

- In the event of complete power failure, the battery switch must be ON to operate the supplemental pump.
- The engine hoist system includes two hydraulic cylinders in the aft fuselage section and a selector valve in the radar observer's cockpit. The hoist system is used by ground crew personnel when engine service is required. The handpump will not maintain sufficient hydraulic pressure for operation of the flight controls.

RIGHT AND EMERGENCY FLIGHT CONTROL HYDRAULIC SYSTEM.

Operating pressure for the right system is normally supplied by an engine-driven, piston-type hydraulic pump on the right engine. This system powers one actuating cylinder of each basic flight control surface. On some airplanes a 28-volt electrically driven, piston-type hydraulic pump in the right hydraulic system is the emergency pressure source for operating the flight controls. The pressurized reservoir for the system and

the electrically driven hydraulic pump are in the right side of the forward fuselage section.

EMERGENCY WING FLAP HYDRAULIC SYSTEM (GROUPS 1 THROUGH 35 AIRPLANES).

This system has its separate hydraulic reservoir and a gear-type hydraulic pump, 28-volt d-c electrically driven, located just aft of the main gear wheel well. The emergency flap system and the emergency flight control system both operate from the emergency flap switch. When the emergency flap switch is placed at ON, the emergency flight control pump operates and a circuit is completed to the wing flap mechanism. Subsequent movement of the wing flap lever starts the emergency flap pump and actuates the flaps. Because of the lower pump capacity, flaps operate more slowly in the emergency system than in the normal system.

CAUTION

On Groups 1 through 25 airplanes, do not operate emergency flap system when left hydraulic system is in operation because fluid will be pumped into the emergency flap reservoir causing overflow and loss of fluid. On Groups 30 and 35 airplanes, to prevent possible loss of hydraulic fluid, the emergency flap system includes an automatic hydraulic pressure switch which will hold the emergency flap system electrical circuit open, regardless of the position of the emergency flap switch, until the left main hydraulic system pressure drops below 1700 psi, as it would in case of left hydraulic system failure.

HYDRAULIC SYSTEM PRESSURE GAGES.

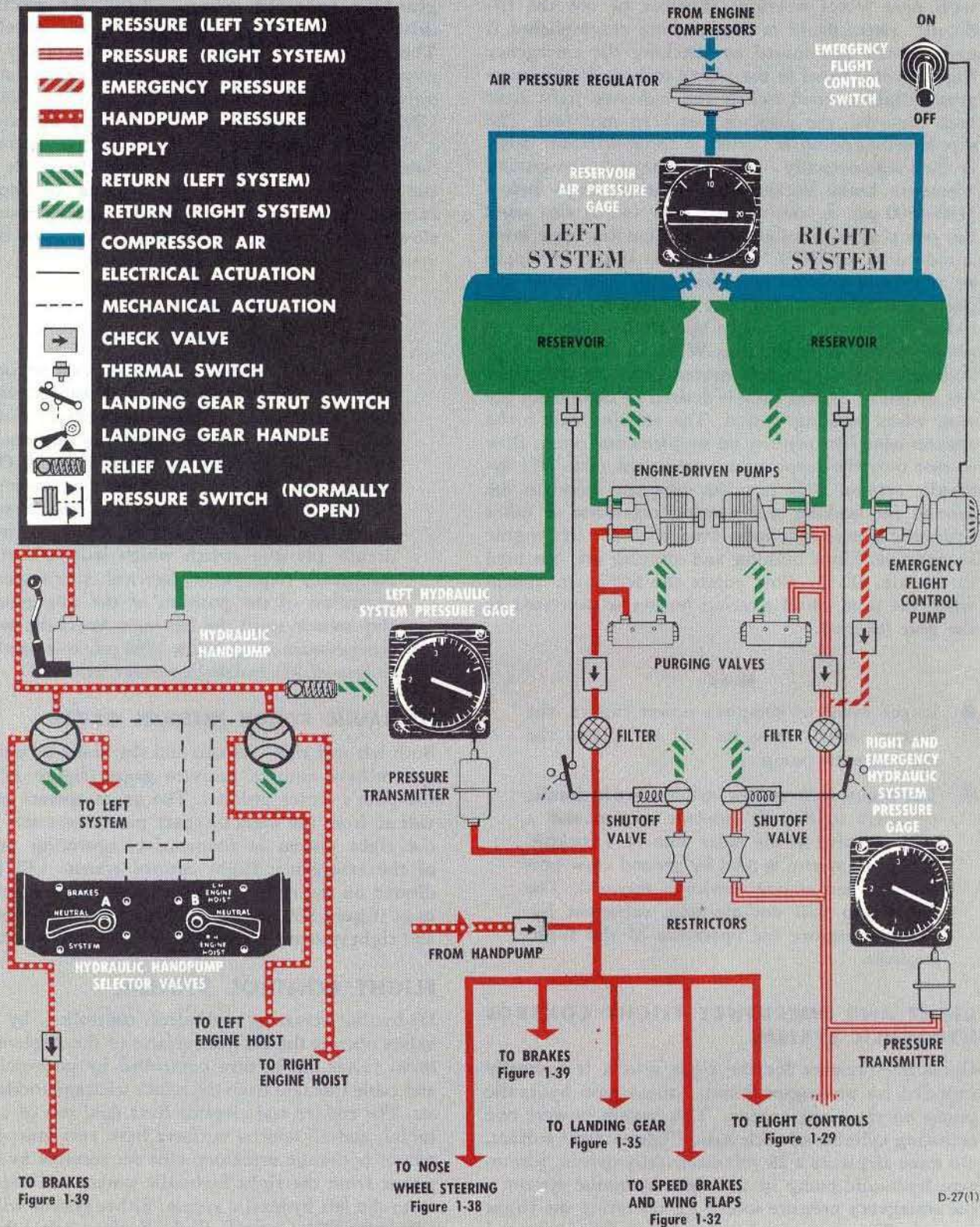
Both left and right systems and the brake accumulator system have autosyn pressure gages (figure 1-10) on the pilot's center pedestal. The gages operate on 115-volt ac from the main or spare power inverter. When the right system is inoperative, operating pressure of the emergency flight control system will be indicated on the right system pressure gage. A pressure gage (figure 1-9) showing the air pressure in both left and right system reservoirs is on the pilot's left console.

FLIGHT CONTROL SYSTEM.

Hydraulic actuating cylinders controlled by servo valves operate the control surfaces of the airplane. The servo valves are in turn controlled by push-pull rods and cable linkages from the pilot's stick and rudder pedals. The rudder and elevator have dual sets of control cables, and all control surfaces have two independent sets of hydraulic actuators. One set receives hydraulic power from the right hydraulic system and the other from the left hydraulic system. Either system will give adequate control for safe flight. Surfaces other than the

HYDRAULIC POWER SUPPLY SYSTEMS

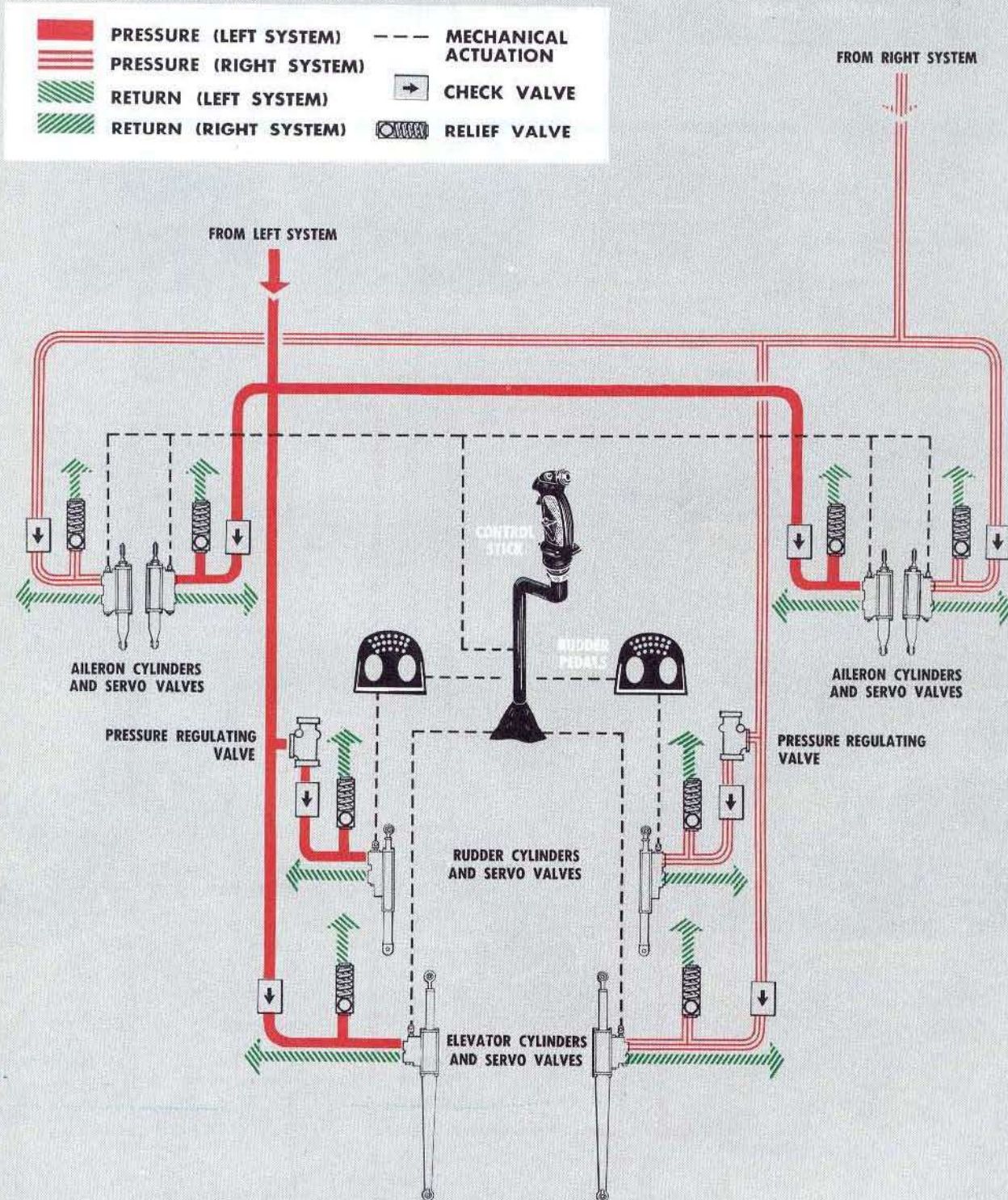
WITH RIGHT HYDRAULIC SYSTEM EMERGENCY FLIGHT CONTROL PUMP



D-27(1)

Figure 1-28.

FLIGHT CONTROL HYDRAULIC SYSTEM



D-28

Figure 1-29.

rudder operate on the 3000-psi system pressure. The rudder actuating cylinders operate on 1500-psi pressure (750 psi on Group 60 and subsequent and some earlier airplanes in compliance with T.O. 1F-89-530) obtained by means of pressure regulators which reduce the normal 3000-psi system pressure. If both hydraulic systems fail, the emergency flight control hydraulic pump will power the right system actuating cylinders. Since the flight control surfaces are fully powered, artificial "feel" has been provided because no forces are transmitted to the stick and rudder pedals. A bobweight on the control force mechanism and a control force bellows, utilizing ram air pressure, provide additional feel for elevator operation. The irreversible surface control hydraulic system prevents the surfaces from moving when the airplane is not in use; however, the control surfaces will eventually droop after the airplane is parked without hydraulic pressure on the system. This is normal and should cause no alarm, as the control surfaces will return to their normal positions when hydraulic power is applied.

CONTROL STICK.

The control stick (figure 1-30) is conventional with the following 28-volt d-c switches on the grip: aileron and elevator trim switch, pylon tanks and bombs release button, rocket firing trigger, radio mike button, autopilot emergency disconnect switch (Group 35 and subsequent airplanes), and, on some airplanes, nose wheel steering button.

RUDDER PEDALS.

The rudder pedals are the conventional suspended type with toe-operated brake pedals. The pedals are adjustable to the desired leg position.

RUDDER PEDAL ADJUSTMENT CRANK.

A rudder pedal adjustment crank (figure 1-10) is on the pilot's center pedestal panel. Rotation of the crank moves both rudder pedals either forward or aft to the desired leg position.

EMERGENCY FLIGHT CONTROL SYSTEM.

An electrically driven emergency hydraulic pump in the right hydraulic system of some airplanes supplies pressure to operate the flight controls if both the left and right hydraulic systems fail. The 28-volt d-c pump, which is powered by the battery bus, supplies pressure to the right hydraulic system at 1500 psi. This results in an adequate but lower degree and rate of control surface deflection.

Note

The emergency flight control system will not operate if there is no fluid in the right hydraulic system.

Emergency Flight Control Switch and Indicator Light (Some Airplanes).

The two-position emergency flight control switch (figure 1-9) on the pilot's left console provides a means of turning the emergency flight control hydraulic pump on and off. When the switch is at ON, the circuit from the battery bus to the emergency flight control pump is completed; the pump operates and the indicator light, directly left of the switch, comes on. When the switch is at OFF, the emergency flight control system is inoperative.

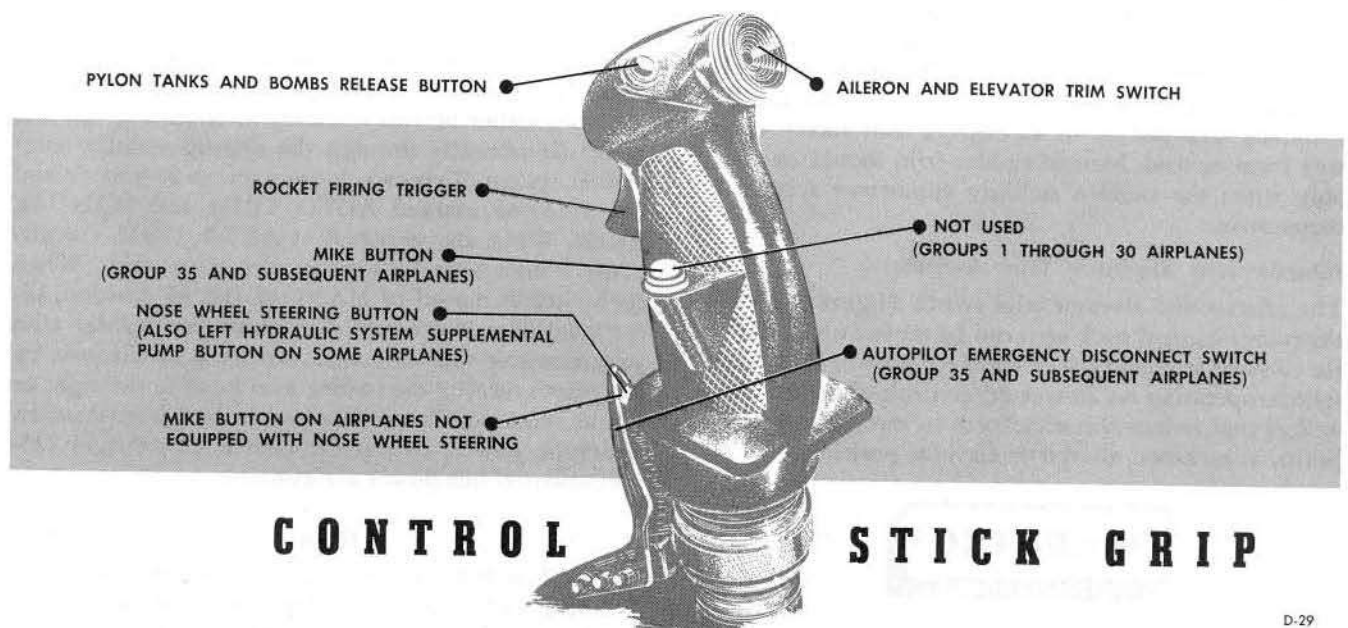


Figure 1-30.

ELEVATOR FEEL SYSTEM.

A control force bellows in the elevator control mechanism lends "feel" for elevator movement in proportion to airspeed. A diaphragm in the bellows is attached so that a movement of the stick in either direction moves the diaphragm against ram air pressure. In flight, ram air from the right pitot head creates a pressure on the diaphragm which must be overcome to move the stick. This pressure increases with airspeed, increasing the resistance to control stick movement. When the airplane is not moving, there is no differential pressure in the bellows and no bellows resistance to control stick movement; however, elevator "feel" is provided by a spring within the bellows. Additional feel on the control stick comes from a bobweight attached to the stick mechanism. When "G" forces are applied to the airplane, the bobweight tends to move the stick toward the position of one "G" flight. The stick force increases as the "G" force becomes greater.

FLIGHT CONTROL TRIM SYSTEM.

The control stick or pedal forces can be relieved by use of the trim system. The ailerons and elevator are trimmed by electric motors that mechanically change the relationship between the "feel" mechanism and the control system to reduce stick force to zero. The trim system operates directly on the control force producers and no trim tabs are used on the control surfaces. Aileron and elevator trim is accomplished by moving the aileron and elevator trim switch on the control stick grip. Limit switches are provided on the elevator trim mechanism to prevent serious overtrim if the switch should stick. Aileron trim travel is 6 degrees each way from neutral. Elevator trim travel is 11 degrees up and 10 degrees down. Rudder trim normally is accomplished through the sideslip stability augmenter. The rudder may also be trimmed manually in emergencies by rotating the emergency rudder trim knob either left or right. The rudder can be manually trimmed up to 40 degrees (full travel) each way from neutral. Manual rudder trim should be used only when the sideslip stability augmenter system is inoperative.

Aileron and Elevator Trim Switch.

The aileron and elevator trim switch (figure 1-30) on the pilot's control stick grip can be moved up or down for elevator trim and left or right for aileron trim. This switch, operating on 28-volt dc, controls electrical trim motors that reduce the stick force to zero, within trim limits, at a chosen aileron or elevator position.

WARNING

The aileron and elevator trim switch is spring loaded to the NEUTRAL position; however,

it should be returned to neutral manually to preclude the possibility of the switch sticking in the actuated position and causing a dangerous overtrim condition in case of malfunction of the limit switches.

Note

The ailerons and elevator cannot be trimmed unless both hydraulic power and 28-volt d-c electrical power are available.

Electrical Rudder Trim Knob.

A rudder trim knob (figure 1-31), located on the sideslip stability augmenter control panel on the pilot's left console, provides the normal means of trimming the rudder manually. Both 115-volt single-phase ac and 28-volt dc are required for effective use of the knob. The knob operates through the sideslip stability augmenter, which has a travel limit of 5 degrees in each direction. Rotation of the knob changes the position of the rudder servo with respect to the neutral pedal position. When the rudder trim knob is rotated clockwise, the rudder deflects to the right. When the rudder trim knob is rotated counterclockwise, the rudder deflects to the left. Normally the knob is centered at a neutral position. On Group 50 and subsequent airplanes, the rudder trim knob is safetied in the neutral position. On these airplanes the knob is used only as an alternate means of trimming the rudder in case of malfunction of the auto trim feature of the (modified) sideslip stability augmenter. To use this trim knob, the rudder trim switch is moved to MANUAL TRIM position and the trim knob is rotated, to the right or left as required, with sufficient force to break the light safety wire.

Rudder Trim Switch (Group 50 and Subsequent Airplanes).

A rudder trim switch (figure 1-31) on the sideslip stability augmenter control panel, provides means for selecting either of two methods of trimming the airplane directionally through the sideslip stability augmenter system. This switch operates on 28-volt dc and has positions marked AUTO TRIM and MANUAL TRIM. When the switch is at AUTO TRIM, the airplane is automatically kept in directional trim. When the switch is moved to MANUAL TRIM position, directional trim is accomplished through a rudder trim potentiometer and the rudder centering mechanism, by the pilot's turning the rudder trim knob to the right or left, as required. The rudder cannot be trimmed unless hydraulic power, 28-volt d-c electric power, and 115-volt essential bus power are available.

Note

At low indicated airspeeds, normally associated with takeoff, landing, and cruise at extreme altitudes, a pressure switch (in the landing gear warning system) overrides the

AUTO TRIM position of the rudder trim switch. This action takes place automatically when the airspeed drops below 165 knots IAS; then the system returns to normal when the airspeed builds up to 180 knots IAS. The rudder trim switch itself does not move, as the pressure switch is in sequence with it. During the time that the autotrim feature is not in operation, electrical manual trim will be available through the sideslip stability augments system just as though the rudder trim switch were placed in MANUAL TRIM position. This automatic switching in and out of autotrim is to prevent undesirable oscillations that might occur if the autotrim feature is operating while the airplane is flying at low indicated airspeeds.

Emergency Rudder Trim Knob (Groups 1 Through 45 Airplanes).

The emergency rudder trim knob (figure 1-31) is located on the pilot's center pedestal and provides a manually operated mechanical means of trimming the airplane directionally if the sideslip stability augments is inoperative. Rotating the knob to the left decreases the force required against the left rudder pedal; rotating the knob to the right decreases the force required against the right rudder pedal. Emergency rudder trim should not be used under normal flight conditions. Moving the rudder trim knob out of neutral will unseat the sideslip stability augments detent. The sideslip stability augments performance is then somewhat impaired since part of the movement of the sideslip stability mechanism is transmitted to the rudder pedals rather than total movement being transmitted to the rudder. The emergency rudder trim knob should be used only if the electric rudder trim knob or the sideslip stability augments is inoperative. The trim knob is safetied in the center position with light wire. If the electric trim fails, the wire should be broken by rotating the knob in the desired direction.

Note

- Do not use the emergency rudder trim knob under normal flight conditions. Using the knob unseats the sideslip stability augments detent.
- If emergency rudder trim has been used in flight, the pilot will enter the fact in DD Form 781 so that the knob will be safetied in the neutral detent before the next flight.
- On Group 50 and subsequent airplanes, a modification of the rudder cable system eliminates the mechanical emergency rudder trim. Rudder trim in these later airplanes may be accomplished by use of the normal and alternate trimming methods controlled by the sideslip stability augments trim switch.

Elevator Trim Position Indicator.

A mechanical elevator trim indicator (figure 1-31) shows the proper trimmed position of the control stick for takeoff. The indicator is located on the floor at the inboard side of the pilot's right console. The indicator pointer is connected directly to the control stick elevator torque tube and the dial is fixed to the structure. The dial has a luminous circular spot marked TAKE-OFF. To trim the stick for takeoff, the stick must be moved until the pointer is at TAKE-OFF. With the stick held in this position, the elevator trim switch on the control stick grip must be actuated until the stick force is reduced to zero. The stick forces should be reduced to zero within 10 seconds and the stick will remain at the indicated TAKE-OFF position.

SIDESLIP STABILITY AUGMENTS SYSTEM (GROUPS 1 THROUGH 45 AIRPLANES).

The sideslip stability augments system controls rudder motion to eliminate sideslip. This improves stability, dampens undesirable oscillations common to most high speed airplanes, and permits fully coordinated turns to be made without use of the rudder pedals. If the airplane begins to sideslip, an accelerometer (liquid type) senses the sideslip and transmits an electrical signal, proportional to the amount and direction of sideslip, to a preamplifier where it is amplified and modified by means of an airspeed compensator. The modified signal then leaves the preamplifier and is combined with signals from an aileron potentiometer and the electrical rudder trim potentiometer. The aileron potentiometer signal is proportional to the amount of aileron deflection, and is also modified by the airspeed compensator. The combined signals are then transmitted into a calibrator unit where the signal is compared with a servo motor signal which indicates the position of the servo actuator shaft. The difference between the combined signal and the servo motor signal determines the amount of servo shaft rotation necessary to correct for the sideslip. This difference, or error signal, is then passed through an amplifier to operate the servo motor which moves the rudder, by means of the rudder cable and actuating cylinders, in the direction to oppose the sideslip. During pushovers and other maneuvers involving negative "G" loads, some yaw is usually experienced due to the action of the liquid type accelerometer. To prevent the rudder cable movement (resulting from the sideslip stability augments) from moving the rudder pedals instead of the rudder actuating cylinders, the main rudder cable drum, located between the sideslip stability augments servo motor and the rudder pedals, is held stationary by a spring-loaded detent. However, if the mechanical emergency rudder trim knob is moved from the neutral position, the detent will be unseated and part of the rudder cable movement will be transmitted to the rudder pedals, resulting in decreased efficiency of the system. The pilot can override the action of the sideslip stability augments by merely pushing the rudder pedals

FLIGHT CONTROL TRIM SYSTEM



Figure 1-31.

farther than normal. A warmup period of approximately 3 minutes is necessary before the system is ready for operation. During this warmup period, the rudder may be deflected as much as 5 degrees (maximum system authority). Therefore, if the system is turned off during flight and then turned on again, the rudder may deflect and the airplane will yaw sharply. For this reason, the system should not be turned off or on during flight. If the sideslip stability augments should fail during flight, the rudder will eventually deflect 5 degrees to one side or the other and will remain deflected until neutralized by trim. The system is powered by the 115-volt single-phase a-c system.

CAUTION

If the sideslip stability augments system should fail, reduce airspeed below the range in which large directional oscillations might occur, thus avoiding undue stress on the airplane's structure.

Sideslip Stability Augments Switch (Groups 1 Through 45 Airplanes).

A switch for the sideslip stability augments (figure 1-31) is located on the sideslip stability augments control panel. This switch has ON and OFF positions and controls the single-phase a-c power that operates the stability augments equipment. The switch should be at ON at all times during flight.

SIDESLIP STABILITY AUGMENTS SYSTEM (GROUP 50 AND SUBSEQUENT AIRPLANES).

On Group 50 and subsequent airplanes, the sideslip stability augments has been modified extensively by changes that improve the performance of the system while reducing the number of component units required. A redesigned single rudder cable system is used and the mechanical rudder trim is eliminated. A sensitive accelerometer of the mass-spring-damper type replaces the liquid type used on Groups 1 through 45 airplanes. The mass-spring-damper type accelerometer has a bobweighted wand to detect lateral movement. The advantage of the newer type accelerometer is that

the sensing element is not affected by negative "G" loads as is the liquid accelerometer. For example, on the earlier system some yaw is usually experienced during pushovers; this characteristic is absent from the modified augmenter. The preamplifier, calibrator, and amplifier have been combined into one electronic control unit. This unit also includes an integrator that evaluates and combines signals from steady-state accelerations (sideslip) with signals from lateral oscillations (Dutch Roll) to provide an automatic trimming feature in the stability augmenter system. Rudder displacement within the range (5 degrees either side of neutral) of the system is controlled by an electrohydraulic servo which is connected in series with the rudder power cylinders. This electrohydraulic servo operates in response to electrical impulses from the electronic control unit. The stability augmenter can be operated selectively either in automatic trim or in manual trim at the pilot's discretion. Automatic trim is recommended at all times and especially during the "on target" stage of interception and the firing phase, because in this setting the system will produce the most completely stabilized flight path at cruising speeds and above; however, the system will provide satisfactorily stabilized flight, and is capable of continuous operation, in the manual trim setting. If a failure occurs in the automatic trim portion of the electronic control unit and power is still available to the system, trim control may be obtained through selection of the manual trim system. The sideslip stability augmenter system can be overridden by moving the rudder pedals farther than normal. The system is powered by 115-volt single-phase ac. If the sideslip stability augmenter system should fail completely in flight, the rudder may deflect as much as 5 degrees (maximum authority) right or left. The rudder will return to neutral, however, within 60 seconds after the sideslip stability augmenter system is turned off.

Sideslip Stability Augmenter Power Switch (Group 50 and Subsequent Airplanes).

A two-position PWR ON, PWR OFF switch (figure 1-31), located on the sideslip stability augmenter control panel, controls the single-phase a-c power that operates the stability augmenter system. The switch is guarded in the PWR ON position, and should be left in that position at all times during flight, except in case of failure of the entire stability augmenter system, in which case it should be placed at PWR OFF.

WING FLAP SYSTEM.

The slotted wing flaps operate on hydraulic power from the left hydraulic system. A wing flap lever on the pilot's left console is connected by cables to the wing flap servo valve mechanism which controls the direction of fluid flow to a hydraulic motor. Four jackscREW actuators, driven by the hydraulic motor

through a series of torque tubes, move the flaps to the desired position. The flaps operate together. Flap travel is 50 degrees down from the wing reference plane.

Emergency Wing Flap System (Groups 1 Through 35 Airplanes).

The emergency wing flap system can be used to operate the flaps when the left hydraulic system fails. Emergency wing flap power is supplied by a 28-volt d-c electrically driven hydraulic pump and reservoir in the left wing aft of the main gear wheel well. The reservoir sight gage can be read through a window in the aft side of the left main gear wheel well. The emergency flap hydraulic system is controlled by the emergency flap switch and the flap lever. On Groups 30 and 35 airplanes, the emergency flap system can be energized only when the left main hydraulic system is inoperative.



On Groups 1 through 25 airplanes, do not operate the emergency flap system when the left hydraulic system is operating because fluid will be pumped into the emergency flap reservoir causing overflow and loss of fluid.

WING FLAP LEVER AND POSITION INDICATOR.

The wing flap lever and position indicator (figure 1-33) are located on the pilot's left console. The lever provides a means of moving the wing flaps to any desired position, and can be pre-positioned at TAKE-OFF (flap 30 degrees down), DOWN (flap 50 degrees fully down), and UP. After the lever has been moved to one of these positions, the lever may be released and the flaps will move to the selected position. Wing flaps will retract from takeoff position in 12 seconds. The flaps can be placed at other positions by holding the wing flap lever in the desired position until the indicator shows the flaps to be in that position. The lever can then be released and the flaps will remain in position until the lever is moved again. As the wing flaps travel, the indicator gives visual indication of the flap position at any time during travel.

EMERGENCY FLAP SWITCH AND INDICATOR LIGHT (GROUPS 1 THROUGH 35 AIRPLANES).

A guarded emergency flap switch and indicator light (figure 1-33) are located directly forward of the wing flap lever and operate on 28-volt dc. The switch has OFF and ON positions and is used to arm the emergency flap pump and to turn on the emergency flight control hydraulic pump. When the switch is placed at ON, the emergency flight control hydraulic pump operates and the emergency flap hydraulic pump is

armed. When the flap lever is then moved to any desired position, the emergency flap pump and the flaps operate. The flap pump automatically stops when the flaps reach the selected position. Both the emergency flap control light and the emergency flight control indicator light come on when the emergency flap system is put into operation.

SPEED BRAKE SYSTEM.

The trailing section of each aileron splits through the

chord line to form two surfaces. The two surfaces, hinged at the front, open to a "V" when used as a speed brake. They are moved by a hydraulic cylinder powered by the left hydraulic system. Flow to the cylinder is regulated by the speed brake lever in the pilot's cockpit through cables and a servo valve. Speed brakes may blow open if the airplane is parked in a tailwind when external speed brake locks have not been installed.

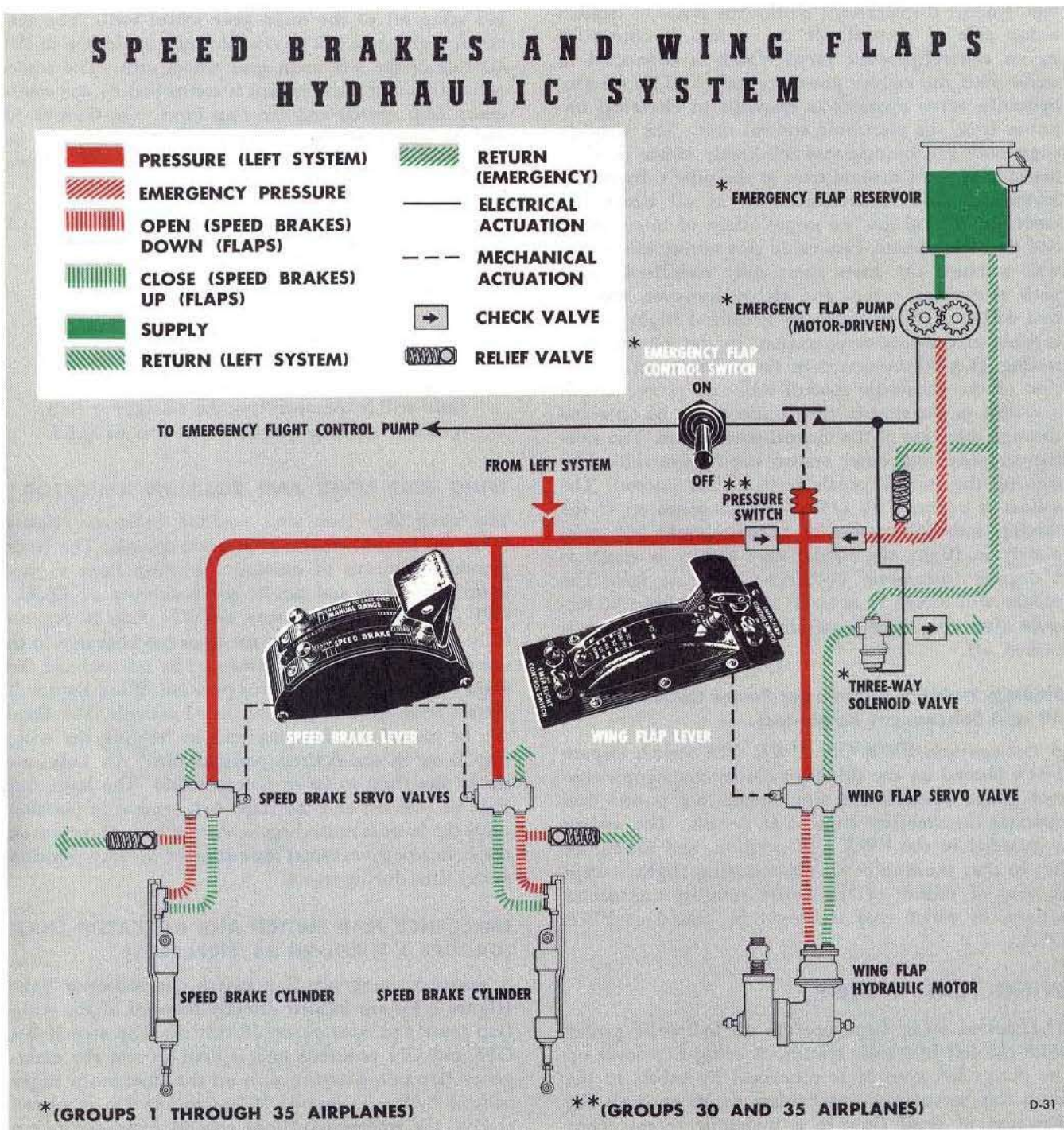


Figure 1-32.

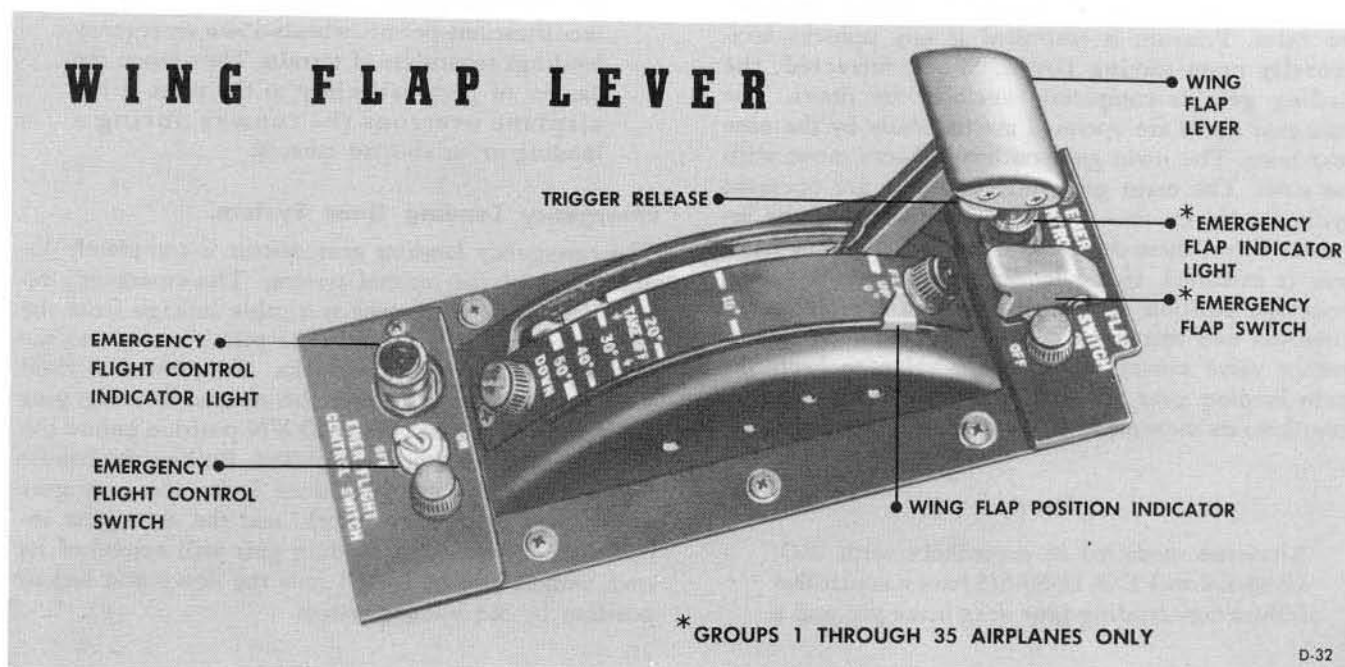


Figure 1-33.

SPEED BRAKE LEVER.

The speed brake lever (figure 1-34), located on the pilot's left console, has OPEN and CLOSED positions and controls the position of the speed brakes. When the speed brake lever is moved, the speed brakes open proportionally to lever movement. The lever can be stopped at any point between OPEN and CLOSED to give intermediate positioning of the speed brakes. At indicated airspeeds up to approximately 260 knots, the speed brakes can be fully opened (120 degrees included angle). At indicated airspeeds above 260 knots, the lever can be pre-positioned at any setting, but the angle to which the speed brakes will open will be decreased in proportion to the increased airspeed. If airspeed is above 260 knots, the airload on the fully open speed brakes applies back pressure on the actuating cylinders in excess of the hydraulic system pressure and speed brakes will "blow back." The pressure will be relieved through a relief valve until the speed brakes close to a position where back pressure on the actuating cylinders is equal to the hydraulic system relief valve pressure. As airspeed is reduced, speed brakes will open to the position preset by the lever.

Note

On some airplanes the speed brake system has been modified to prevent pre-positioning of the speed brake lever toward the CLOSED position. The speed brake lever must be pushed forward manually as the speed brakes close.

LANDING GEAR SYSTEM.

The airplane has a tricycle landing gear which operates on power from the left hydraulic system and is controlled in normal operation by the landing gear lever in the pilot's cockpit. The two single-wheel main gears retract inboard into the wing and the dual wheels on the nose gear retract vertically into the fuselage. A selector valve, a sequence valve, and actuating cylinders extend and retract the landing gear and the main landing gear inboard doors. The selector valve, attached by mechanical linkage to the pilot's landing gear lever, directs the flow of hydraulic fluid in the actuating cylinders to raise and lower the landing gears and operate the main landing gear inboard doors. The sequence valve reverses the action of the hydraulic pressure in the actuating cylinders of the inboard doors to synchronize the opening and closing of the inboard doors with the retraction and extension of the main landing gears. If the pressure in the left hydraulic system drops below 1450 psi, a priority valve closes to give the flight control system priority over the landing gear system by shutting off the flow of fluid through the landing gear selector valve. Independent air bungee systems aid normal and emergency extension of the landing gears. Landing gear extension or retraction normally takes 6 seconds; however, when the engine rpm is below 80%, additional time may be required. The pilot can reverse the normal landing gear cycle at any time with a reverse movement of the landing gear lever. Hydraulic pressure is automatically relieved when all landing gear components are up and locked; a normally open hydraulic shutoff valve, operating on 28-volt dc and controlled by microswitches,

D-32

closes and shuts off the hydraulic pressure to the selector valve. Pressure is reapplied if any uplocks accidentally open during flight. When retracted, the landing gear is completely enclosed by doors. The nose gear doors are operated mechanically by the nose gear truss. The main gear outboard doors move with the strut. The main gear inboard doors are operated hydraulically by two actuating cylinders and the sequence valve; these doors close and lock after the main gear is extended. If the landing gear lever is moved from one position to the other before completion of extension and retraction, a transfer piston on the sequence valve moves the sequence valve to keep the main landing gear inboard door open until the gear completes its movement in the changed direction.

Note

Airplanes modified in accordance with T.O. 1F-89-520 and T.O. 1F-89-615 have a controlled failure nose landing gear drag brace pin and a

reinforced pilot's cockpit floor. These modifications permit wheels-down emergency landings regardless of terrain. They lessen the danger of personal injury to the pilot if the airplane overruns the runway during a landing or an aborted takeoff.

Emergency Landing Gear System.

The emergency landing gear system is completely independent of the normal system. The emergency release for the landing gear is a cable linkage from the emergency release handle in the pilot's cockpit to the landing gear and door uplocks. To prevent a fluid lock in the gear cylinders, the normal landing gear lever must be placed at the DOWN position before the emergency release handle is pulled. Pulling the handle will release the nose gear door locks, the nose gear uplock, the main gear uplock, and the main gear inboard door locks. The landing gear will extend of its own weight and be forced into the down and locked position by the bungee system.



Figure 1-34.

Landing Gear Ground Locks.

Ground safety locks (figure 1-36) are provided for the landing gear. The main gear locks are installed between the hinge end of the lower side brace and the point where the actuating cylinder attaches to the strut. The nose landing gear ground lock is a clip which slips over the downlock cylinder and is pinned in place. All ground locks have red streamers attached.

LANDING GEAR LEVER.

The landing gear lever (figure 1-37), located on the pilot's left vertical console, is mechanically linked to the landing gear selector valve. The lever knob contains a red light that indicates an unsafe gear position for landing. When the lever is moved to the DOWN position, the nose gear door locks are opened mechanically and slightly in advance of the nose gear uplock.

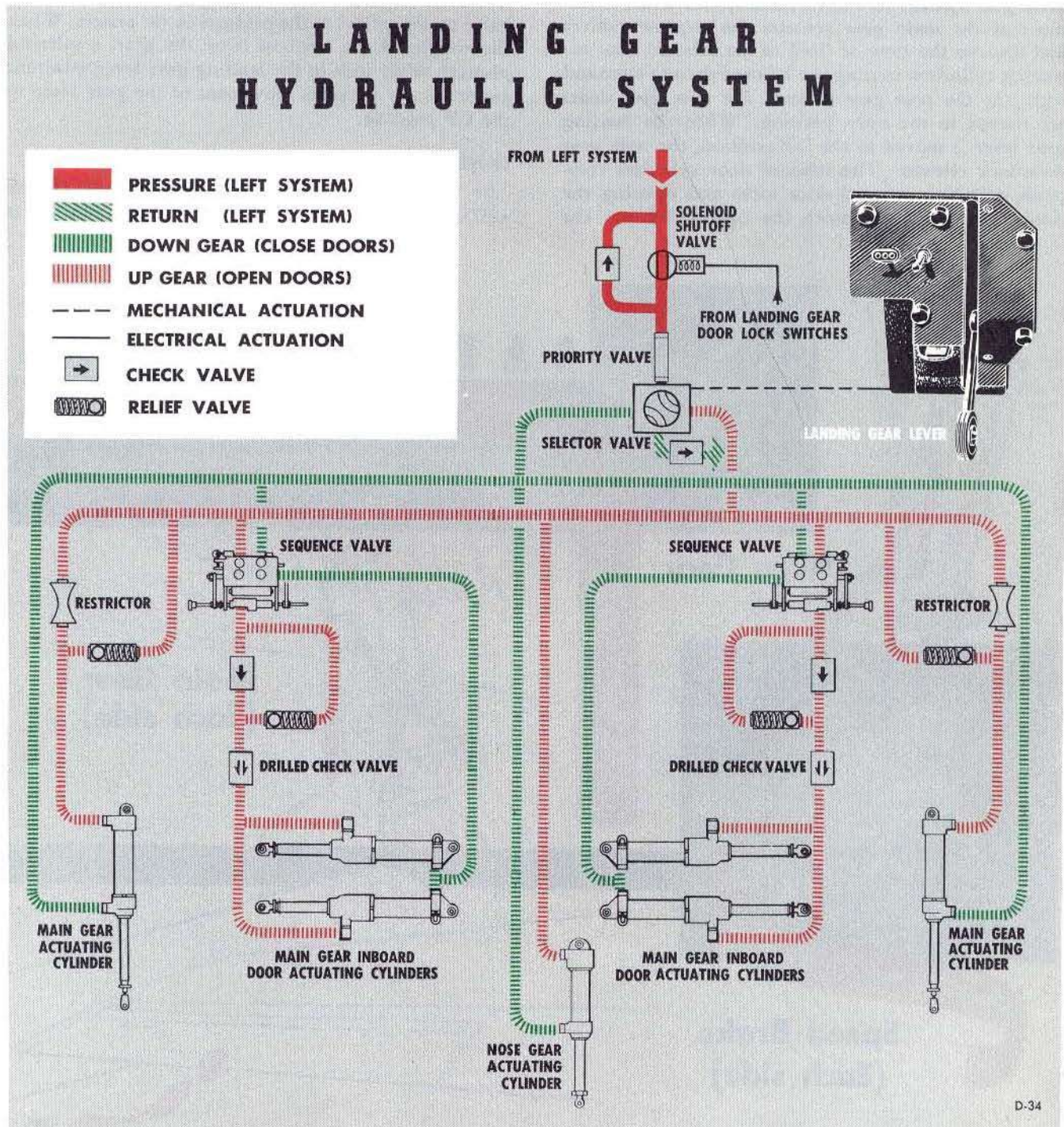


Figure 1-35.

The nose gear uplock switch for the electrically operated hydraulic shutoff valve opens the circuit to the shutoff valve. The valve opens and allows system pressure through to the priority valve and the selector valve. Hydraulic power is supplied simultaneously to the actuating cylinders of the nose gear, main gear, and inboard doors. As the main landing gear inboard door cylinders are compressed, the inboard door locks release and the door opens, releasing the outboard door locks. Final movement of the inboard doors releases main gear uplocks through a cable system. Final movement of the main gear actuates the sequence valves and reverses the flow of fluid to the inboard door actuating cylinders, causing the inboard door to close and lock. As the nose gear extends, the nose gear doors are moved to the open position. When the landing gear lever is moved to the UP position, the nose gear downlock releases. The inboard door cylinders compress, releasing inboard door locks and opening the doors. As the doors reach the open position, the

landing gear actuating cylinders simultaneously retract the nose and main gear. As the nose gear retracts, the nose gear truss engages the nose gear door operating mechanism and the doors close and lock. The main gear outboard door is closed by the action of the main gear shock strut. As the main gear enters its uplocks, the sequence valve is actuated and reverses the flow of fluid to the inboard door actuating cylinders, closing and locking the doors. When all the doors lock, the microswitches for the hydraulic shutoff valve are actuated, the circuit is energized and the shutoff valve closes, relieving the pressure in the system. When the weight of the airplane is on the gear, a solenoid plunger safety lock in the landing gear lever quadrant automatically prevents movement of the gear lever to the UP position.

LANDING GEAR EMERGENCY RELEASE HANDLE.

The landing gear emergency release handle (figure 1-37), located on the pilot's left vertical console, is

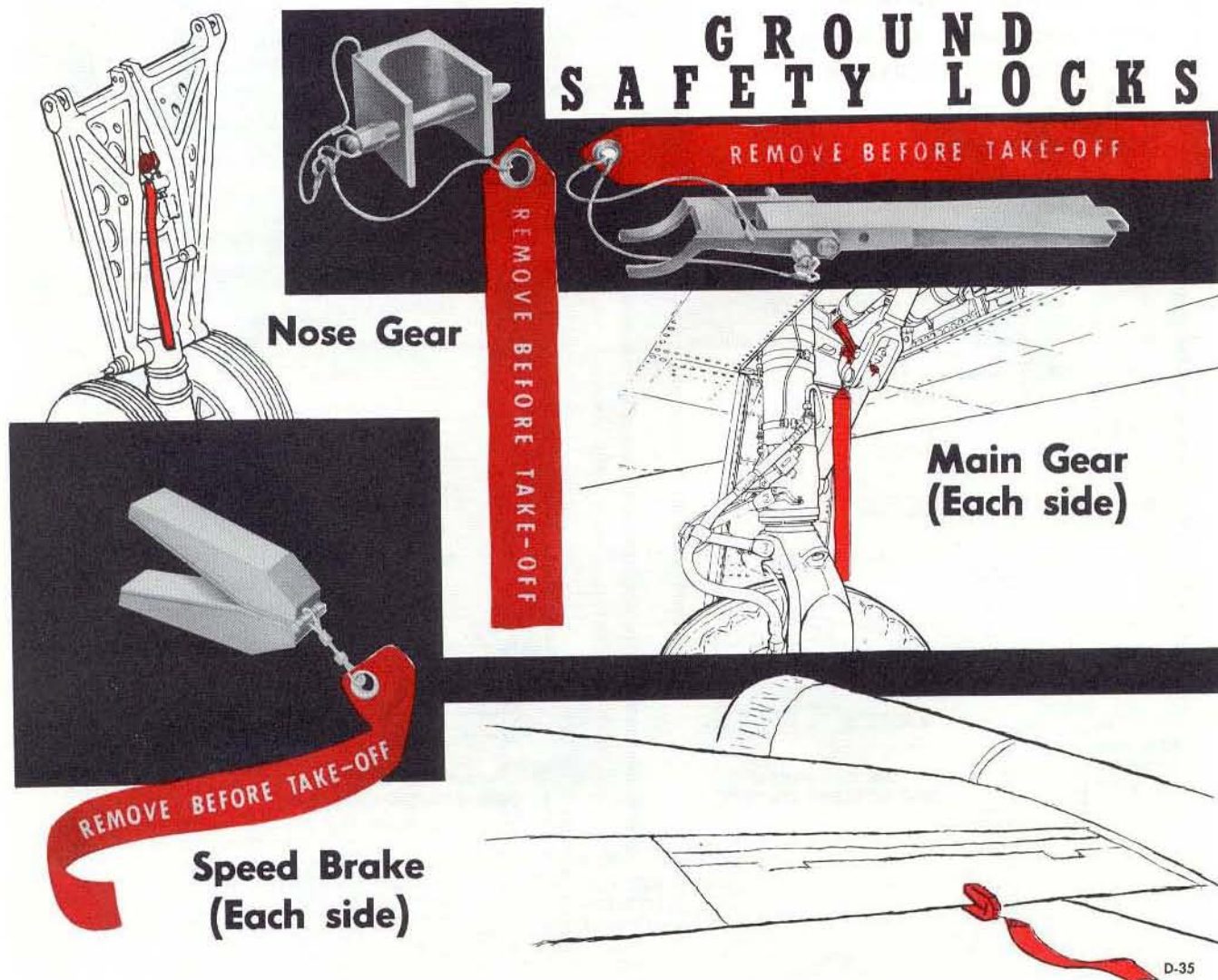


Figure 1-36.

provided to lower the landing gear when the normal system fails. Before the emergency release handle is pulled, the landing gear lever must be placed at DOWN. When the emergency release handle is pulled to its full limit of travel (approximately 14 inches), the locks for the main gear inboard doors and the nose gear doors, and the uplocks for the main and nose gear are opened mechanically by the cable system. The landing gear extends of its own weight and is forced into the down and locked position by the air bungee systems. As the main gear extends, it pushes the inboard door open, and the door remains open until hydraulic pressure is again applied to the system. The emergency release handle requires a hard pull of approximately 80 pounds to release the locks. The pilot

can feel each set of main gear locks release: first the right gear, then the left. The nose gear will not be felt as it is unlocked by the downward movement of the landing gear lever. After the gear is down the emergency release handle must be guided back to the stowed position to prevent whipping. Since use of the emergency system does not affect the operation of the normal system, no readjustments are necessary after the landing gear has been lowered by the emergency system; as soon as hydraulic pressure is available the gear may be operated by the normal method.

LANDING GEAR EMERGENCY OVERRIDE LEVER.

If it is necessary to retract the landing gear with the airplane on the ground, or if the solenoid plunger

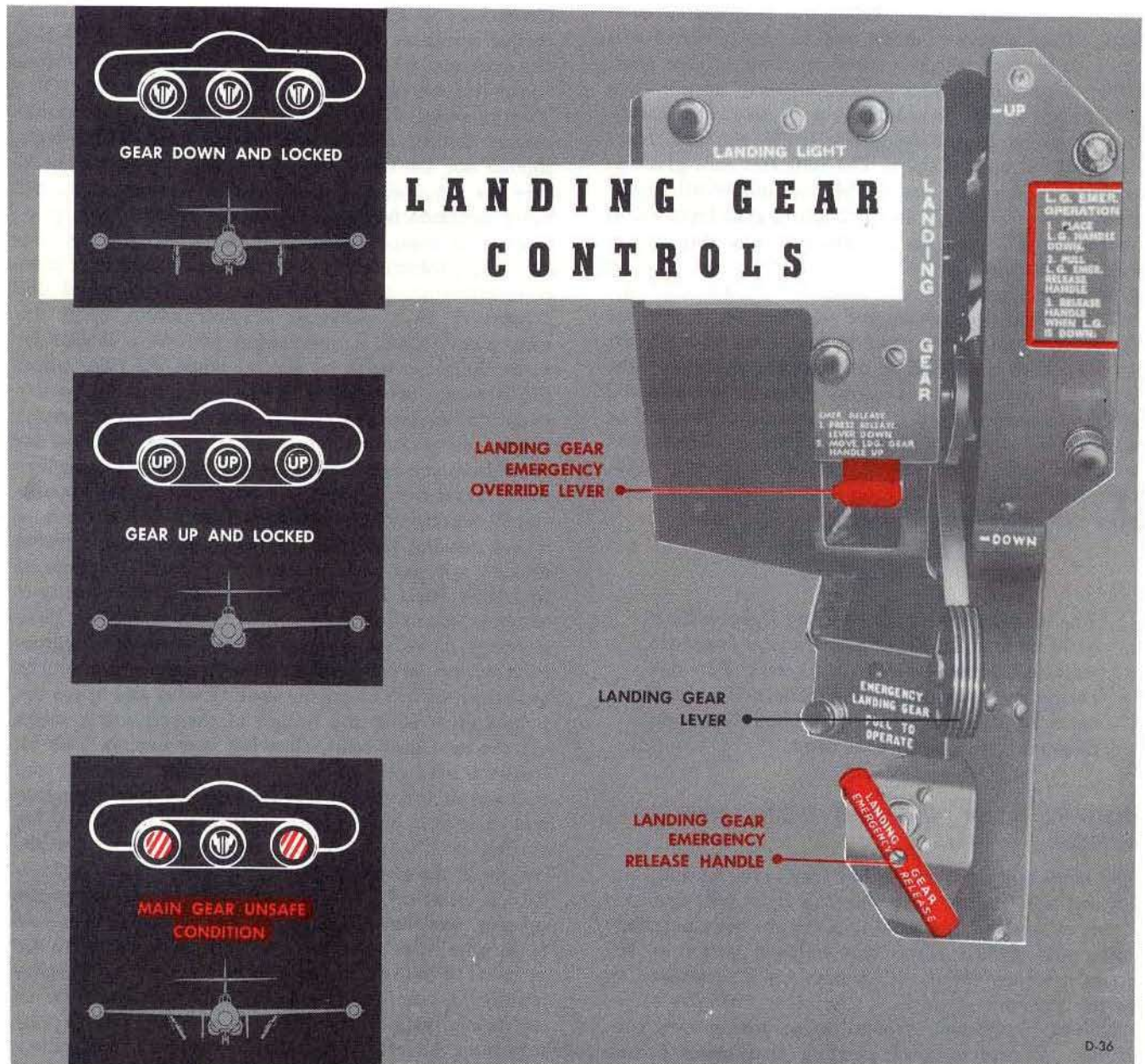


Figure 1-37.

safety lock fails, an emergency override lever (figure 1-37) releases the lock. When the airplane is on the ground, the safety lock holds the landing gear lever in the DOWN position to prevent accidental retraction of the landing gear. The lock is automatically retracted when the weight of the airplane is off the wheels. The gear lever can be released in an emergency by inserting a finger in a hole in the landing gear lever quadrant and pressing the override lever down at the same time the gear lever is moved up. On Group 30 and subsequent airplanes the override lever has been extended to make it visible and more accessible to the pilot.

LANDING GEAR POSITION INDICATORS.

A landing gear position indicator (figure 1-37) on the pilot's instrument panel shows the position of each gear. When a gear is down and locked, a wheel will show in a small window corresponding to that gear. When a gear is up and locked, UP will appear in a window. If a gear is unlocked or in an unsafe condition or if the 28-volt d-c power is off, red and cream diagonal stripes will show. The indicator tabs give the position of the gears only; they are not wired to the gear doors. A red light in the landing gear lever knob, operating on 28-volt dc, will come on and stay on for any unsafe condition of the landing gear or landing gear doors. The light will also come on any time the warning horn is sounding and will stay on to indicate the gear is not down and locked even though the warning horn is shut off by the reset switch. If the light is indicating that the gear is not down at low airspeed and low altitude, it will go off when either airspeed or altitude is increased. On some airplanes, landing gear warning light brightness is controlled during night operations with a dimming switch located on the pilot's aft miscellaneous panel.

Note

The landing gear lever warning light will remain on until the inboard main gear doors are retracted, even if the gear is safe. For this reason, the gear position indicators and a visual check for safe main gear should be relied upon following emergency gear drop.

LANDING GEAR WARNING HORN AND RESET BUTTON.

The landing gear warning horn will give a steady signal and the landing gear warning light will come on if one or more of the landing gears are not completely down and locked when the airspeed drops to 165 knots, plus or minus 10 knots. An altitude-sensing switch prevents a warning signal at altitudes above 10,000 to 13,000 feet, depending on atmospheric conditions. A landing gear warning horn reset button (figure 1-18) on the pilot's aft miscellaneous control

panel can be pressed to shut off the horn. The warning system will be recycled if either the altitude or the airspeed is increased above the warning range or if the landing gear is extended. If the pilot does not use the reset button, the horn will stop blowing automatically when the airspeed reaches approximately 175 knots.

Note

A quick check of the indicator light in the landing gear lever knob can be made when the gear is down and locked. Pressing the warning horn reset button will cause the indicator light to come on.

NOSE WHEEL STEERING SYSTEM.

On Group 40 and subsequent airplanes, and on those earlier airplanes in compliance with T.O. 1F-89-228, the dual nose wheel is equipped with a steering system controlled by rudder pedal action. (See figure 1-38.) The purpose of the system is to provide directional control during taxiing and takeoff only. The system should not be used during landing. Hydraulic pressure for the system is controlled by a solenoid shutoff valve operated by a button on the control stick grip. When the shutoff valve is open, a servo valve, mechanically controlled by the rudder pedals, directs pressure, according to the direction of rudder pedal displacement, to a vane-type actuator which turns the nose wheel strut. A mechanical follow-up device returns the servo valve to neutral when the nose wheel displacement corresponds to the magnitude of rudder pedal deflection. The first 50 percent of rudder pedal displacement causes the nose wheel to rotate only 6 degrees from center. The remaining 50 percent of rudder pedal travel rotates the nose wheel through the remaining 40 degrees of angular displacement. When the nose wheel steering system is not being used (shutoff valve closed), a bypass valve is open to permit free flow of hydraulic fluid between both sides of the vane-type actuator, thus allowing the nose wheel to swivel. Both steering and swivel range of the nose wheel is 46 degrees each side of the centered position. A limit switch on the nose gear scissors closes the shutoff valve and opens the bypass valve when the weight of the airplane is taken off the nose gear strut, allowing it to extend. This allows the nose gear to swivel so that the centering cam will center the nose wheel for landing gear retraction and extension. Nose wheel steering may be selected for taxiing and takeoff at any time (assuming that the weight of the airplane is on the nose wheel and hydraulic and electrical power are available) regardless of the relative positions of the nose wheel and rudder pedals. If the nose wheel position does not correspond with the position of the rudder pedals when nose wheel steering is selected, the nose wheel will turn to correspond to the rudder pedal position. The system operates on pressure from the left hydraulic power supply system. Electrical components are powered by the 28-volt d-c bus.

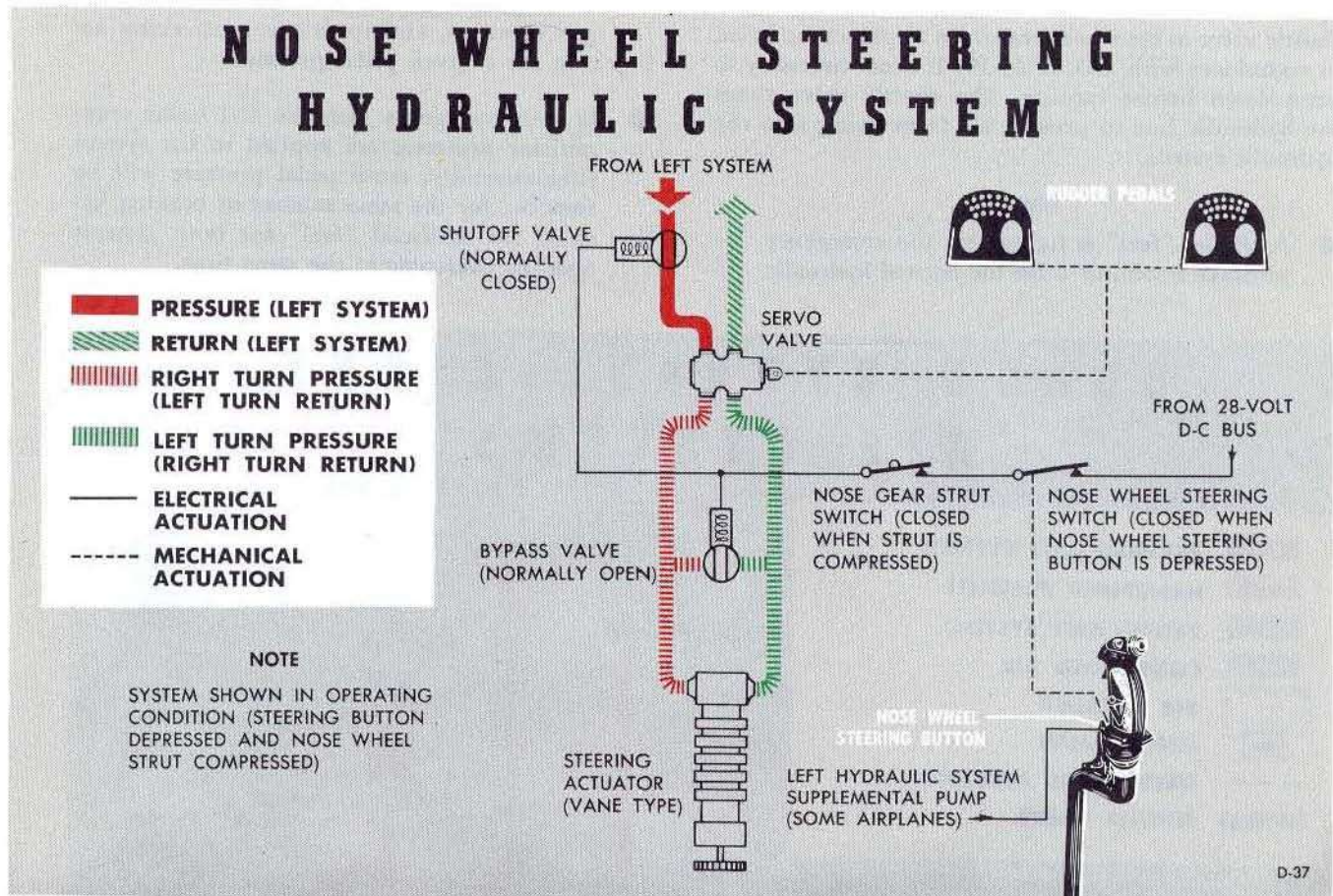


Figure 1-38.

NOSE WHEEL STEERING AND SUPPLEMENTAL HYDRAULIC PUMP BUTTON.

A spring-loaded nose wheel steering button on the control stick grip (figure 1-30) controls the 28-volt d-c shutoff valve and the actuator bypass valve in the hydraulic steering system, and, on airplanes so equipped, the left hydraulic system supplemental pump. When the button is pressed, the shutoff valve opens, the bypass valve closes, the supplemental pump starts, and hydraulic pressure is supplied to the system. Subsequent movement of the rudder pedals will then turn the nose wheel in the direction and to the degree desired. The button must be held depressed during nose wheel steering operation. When the button is released, the shutoff valve closes, the bypass valve opens, and the nose wheel swivels freely. A limit switch on the nose gear scissors overrides the steering button and prevents the steering system from operating when the weight of the airplane is not on the nose gear. However, pressing the button in flight will still start the supplemental pump to augment left hydraulic system pressure if the airplane is equipped with the pump.

BRAKE SYSTEM.

The main gear wheel brakes operate hydraulically, using pressure from the brake accumulator (which is

pressurized by the left hydraulic system). The power brake valves, operated by depressing the brake pedals, individually meter fluid to the wheel brakes. If the left hydraulic system fails, brakes normally will be operated by the pressure in the brake accumulator. In an emergency, when the accumulator pressure is gone, an emergency airbrake is available. (See figure 1-39.) On airplanes equipped with the supplemental hydraulic pump, a normally open pressure switch in the brake accumulator closes when pressure drops to between 1100-800 psi (or below). The switch starts the supplemental pump to replenish braking pressure.

Note

Enough hydraulic brake pressure for parking or towing can be obtained by operating the hydraulic handpump in the radar observer's cockpit (figure 4-8).

Emergency Airbrake System.

If the normal hydraulic brake pressure is lost, a 1500-psi storage bottle in the nose wheel well contains enough air for at least three complete brake applications. Pressing down and turning the emergency airbrake handle to ON and then pressing a brake pedal

operates an airbrake valve and meters air through a shuttle valve to the wheel brake. On airplanes modified in accordance with T.O. 1F-89-599 it is not necessary to press down before turning. The shuttle valve closes the hydraulic line to prevent air from going into the hydraulic system.

Note

- Artificial "feel" is lighter for the emergency airbrake system than for the normal hydraulic

brake system; therefore, when using the emergency system, anticipate greater braking action for a given pedal pressure.

- If both emergency airbrake and brake accumulator pressures are applied to the system simultaneously, more pedal pressure will be required for the same amount of braking because the artificial "feel" for both systems must be overcome at the same time.

BRAKE HYDRAULIC AND AIR SYSTEMS

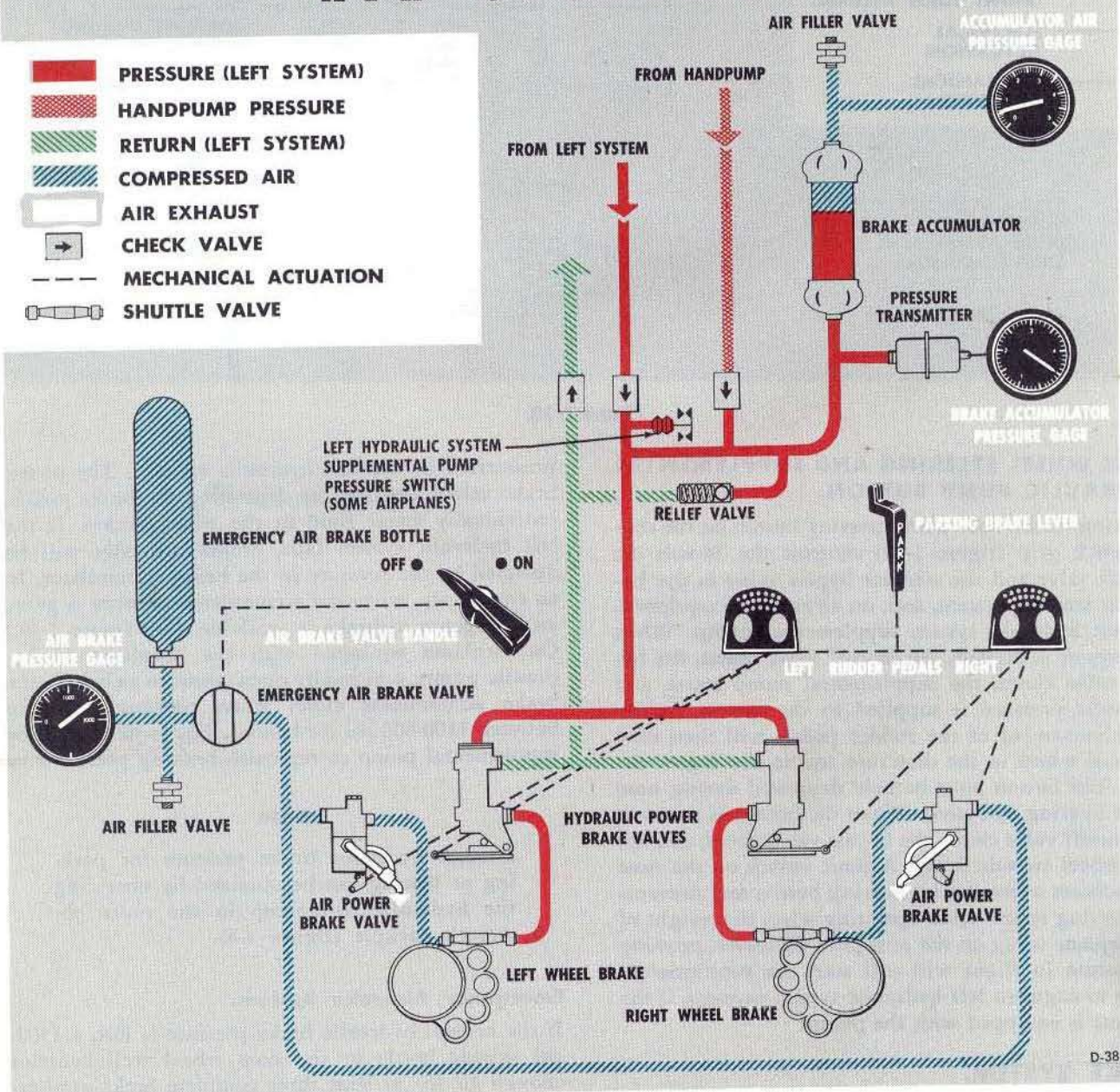


Figure 1-39.

BRAKE PEDALS.

The brake pedals are the conventional, toe-operated type. Each pedal controls a hydraulic power brake valve and an air power brake valve. When the pedals are pressed, all four valves open and either air or hydraulic pressure, or both, supply the braking action to the wheels. "Feel" will be absent unless pressure is available to one of the power brake valves. Application of both air and hydraulic pressure increases the pedal pressure required to obtain the same braking result.

PARKING BRAKE LEVER.

Pulling up on the parking brake lever (figure 1-10), located on the pilot's center pedestal, while depressing the brake pedals sets the parking brakes. The parking brakes are released by manually releasing the parking brake handle slowly while depressing the brake pedals.

EMERGENCY AIRBRAKE VALVE HANDLE.

The emergency airbrake valve handle (figure 3-10) is located on the pilot's left console. Normal operation of the emergency airbrake valve handle is first to push down, then turn. On Group 75 airplanes the emergency airbrake valve and handle assembly have been modified so that the handle need not be depressed before turning. When the handle has been turned to ON and the brake pedals depressed, air is metered to the wheel brakes.

INSTRUMENTS.**Note**

This paragraph covers only those instruments which cannot be considered part of a complete system.

The free air temperature gage and the turn and slip indicator operate on 28-volt dc. All the gyro-type instruments except the turn and slip indicator operate on 115-volt three-phase ac. The standby magnetic compass, a self-contained unit of conventional type, is suspended from the windshield structure above and to the right of the pilot's instrument panel. This magnetic compass serves as a reserve directional indicator in case the directional indicator (slaved) or the 28-volt d-c power fails.

INSTRUMENT PANEL VIBRATORS.

An instrument panel vibrator on the pilot's and radar observer's instrument panels prevents the instruments from sticking. Each unit, a miniature 28-volt d-c motor driving an eccentric weight, operates continuously when the 28-volt d-c power is on and the circuit breaker is closed.

MACHMETER (GROUP 20 AND SUBSEQUENT AIRPLANES).

A type A-1 machmeter (figure 1-8), with the dial graduated in tenths and hundredths Mach, is on the pilot's instrument panel. The pointer indicates, regardless of

altitude and ambient temperature, the Mach number at which the airplane is being flown. Numbers on the dial run in tenths from 0.3 to 1.0 (below Mach 0.3 the graduations are omitted because in this low speed range the airspeed indicator provides a more useful reference).

AIRSPEED INDICATORS.

The pilot's airspeed indicator (figure 1-8) is calibrated in knots and has two pointers: a fluorescent pointer that indicates airspeed and a red pointer (with alternate bands of fluorescent white on Group 35 and subsequent airplanes) that shows airspeed which corresponds to a preset Mach number for the existing altitude. Clockwise movement of the red pointer is limited by a stop which is preset at the limiting structural airspeed of the airplane. When the two pointers meet, the airplane is flying at the maximum allowable airspeed or the maximum allowable Mach number, whichever is less. On Group 35 and subsequent airplanes, the upper half of the indicator dial contains a window exposing a drum, graduated in 2-knot divisions and geared to the main indicator pointer, which enables the indicated airspeed to be read accurately to within 1 knot. The radar observer's airspeed indicator (figure 4-6) is calibrated in knots and shows true airspeed. In the true airspeed indicator a temperature-sensing bulb and an altitude diaphragm automatically compensate for temperature and altitude variations that affect the airspeed reading.

ALTIMETER.

The pilot's altimeter, located on the pilot's instrument panel (figure 1-8), displays barometric pressure indications calibrated in feet of altitude. The altimeter has two hands, a notched disk with a pointer extension, two setting marks, a warning indicator and a barometric scale with an adjustment knob. The longer of the concentrically arranged hands indicates hundreds of feet, the shorter hand indicates thousands of feet, and the notched disk with a pointer extension indicates ten thousand feet. A warning indicator consisting of a striped (cross-hatched) sector painted on a dial above numeral five appears through the notched disk at altitudes below 16,000 feet. An outer setting mark indicating hundreds of feet and an inner setting mark indicating thousands of feet operate in conjunction with the barometric scale and are used when the pressure to be read is outside the limits of the barometric pressure scale. The adjustment knob is used to adjust the hands, setting marks, and barometric scale simultaneously to correct for atmospheric pressure changes caused by changing climatic conditions. The radar observer's altimeter (figure 4-6) is located on the radar observer's instrument panel.

ACCELEROMETER.

A type B-6 accelerometer (figure 1-8) on the pilot's instrument panel indicates both positive and negative

accelerations. The accelerometer has three pointers. The main pointer indicates existing accelerations. The two auxiliary pointers stop at the highest acceleration that has been reached; one indicates maximum positive acceleration, and one indicates maximum negative acceleration. A knob on the front of the instrument case is used to reset the auxiliary pointers to zero. Until they are reset, the auxiliary pointers will show the maximum plus and minus movements of the main pointer.

ATTITUDE INDICATOR.

A type B-1A attitude indicator (figure 1-40) on the pilot's instrument panel indicates the airplane's attitude with respect to an artificial horizon. The instrument obtains d-c power from the 28-volt d-c bus and a-c power from the instrument inverter bus. The B-1A indicator is noncaging and incorporates a zero-pitch trim knob that positions both the sphere and the horizon bar to the zero position. The pitch trim knob has a triangular mark for zero-pitch trim, three dots corresponding to a one-half inch deflection in the downward direction, and six dots corresponding to a one-inch deflection in the upward direction. The indicator has a followup rate of 180 degrees per second in the pitch and bank axis. The indicator has a fast initial erection period, approximately 2 minutes $\pm$ 30 seconds, but if the indicator tumbles in flight, erection may take 15 minutes. Included in the indicator is an electrically driven power warning flag that disappears from view when the indicator is up to full speed and the system is ready for operation. The flag will appear in case of a complete a-c or d-c power failure. However, a slight reduction in a-c or d-c power, or failure of certain electrical components within the system will not cause the flag to appear, even though the system is not functioning properly. The instrument operates through 360 degrees of roll and through 164 degrees of

pitch. The instrument is compensated for turn-errors; however, the lower sensitivity limit of the turn-error compensating mechanism is 40 degrees per minute. Any turn made below 40 degrees per minute will result in turn-errors common to other instruments. Turns made above 40 degrees per minute will be compensated for turn-errors. In level flight, the maximum error in the indication of the airplane's attitude is less than one-half degree.

WARNING

- It is possible that a malfunction of the attitude indicator might be determined only by checking it with the directional indicator (slaved) and the turn and slip indicator.
- A slight amount of pitch error in the indication of the type B-1A attitude indicator will result from accelerations or decelerations. It will appear as a slight climb indication after a forward acceleration and as a slight dive indication after deceleration when the airplane is flying straight and level. This error will be most noticeable at the time the airplane breaks ground during the takeoff run. At this time a climb indication error of approximately one and a half bar widths will normally be observed; however, the exact amount of error will depend upon the acceleration and elapsed time of each individual takeoff. The erection system will automatically remove the error after the acceleration ceases. If the power supply to the attitude indicator is interrupted, the instrument will be unreliable for 1 minute.

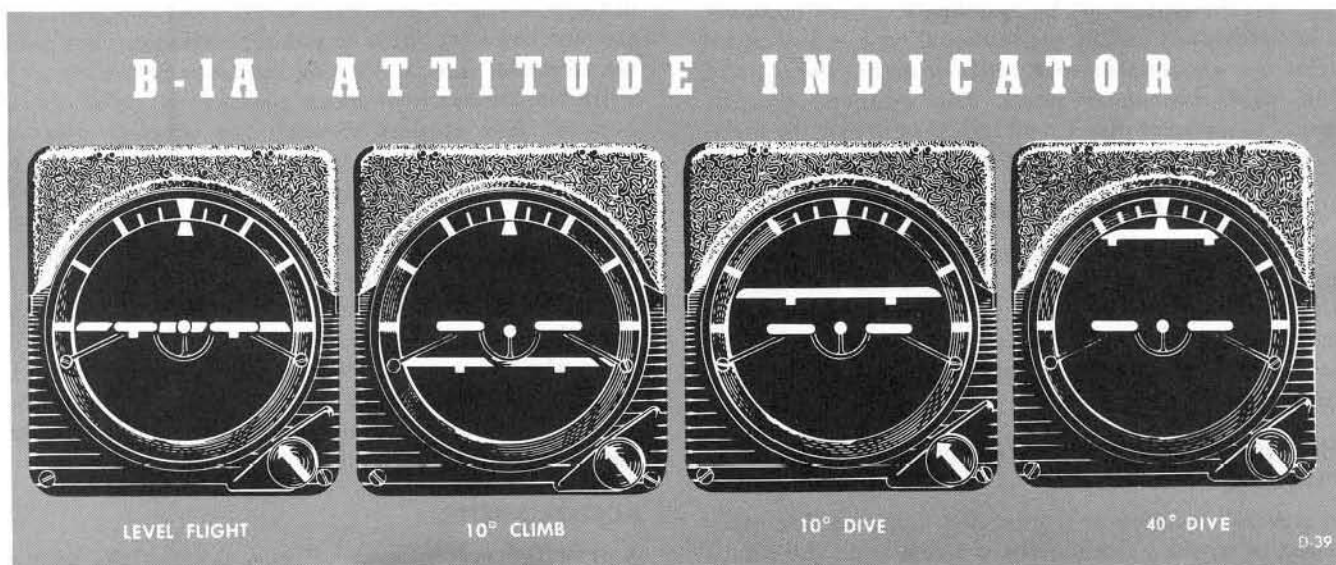


Figure 1-40.

EMERGENCY EQUIPMENT.

FIRE EXTINGUISHING SYSTEM.

The fire extinguishing system has overheat detectors and fire detectors in each engine nacelle, and a single bromochloromethane extinguisher bottle in the nose wheel well with a discharge line to each engine. Two electrically fired, cartridge-operated release valves and a pressure gage are assembled on the bottle. When either engine fire selector switch is actuated, the main engine fuel valve is closed and the electrical circuit for the fire extinguishing system is armed. When the agent discharge switch is closed, current flows to the selected discharge valve on the bottle and fires the cartridge which pierces a frangible disk. The bottle discharges its entire contents into the manifold of the selected engine; the agent vaporizes and so dilutes the oxygen content of the air in the engine bay that it will no longer support combustion. If both fire selector switches are actuated before the agent discharge switch is actuated, the charge will be distributed to both engines but it will be insufficient to put out the fire in either engine. Both the fire extinguishing system and its controls operate on power from the 28-volt d-c bus. Overheat lights, fire warning lights, and controls for the extinguisher are located on a fire control panel on the pilot's right vertical console.

WARNING

Repeated or prolonged exposure to high concentrations of bromochloromethane (CB) or decomposition products should be avoided. CB is a narcotic agent of moderate intensity but of prolonged duration. It is considered to be less toxic than carbon tetrachloride, methyl bromide, or the usual products of combustion. In other words, it is safer to use than previous fire extinguishing agents. However, normal precautions should be taken including the use of oxygen when available.

CAUTION

This is a "one-shot" fire extinguisher system and must be recharged after each use.

Overheat Detector Test Switch and Warning Lights (Some Airplanes in Groups 1 Through 65).

Two amber overheat warning lights (figure 1-41) on the fire extinguishing control panel come on when the temperature in the engine bay areas rises above 178°C (350°F). When the spring-loaded overheat detector test

switch adjacent to the warning lights is held at LH ENG or RH ENG, the corresponding warning light will come on within 2 seconds if the circuit operation is normal. The overheat warning lights, the overheat detector test switch, and the overheat detector circuits operate on 28-volt dc.

Fire Detector Test Switch and Warning Lights (Some Airplanes in Groups 1 Through 65).

Two red fire warning lights (figure 1-41), one for each engine, are on the fire extinguishing control panel and will come on when a rapid temperature rise occurs in the engine area. A spring-loaded fire detector test switch next to the engine fire selector switches can be used to test operation of the fire detector circuits. When the switch is held at CIRCUIT 1, both lights should come on within 10 seconds to indicate that half of the detector circuits in both engine bays are operating. When the switch is held at CIRCUIT 2, both lights should come on within 10 seconds to indicate that the other half of the detector circuits are operating. The fire detector test switch, warning lights, and fire detector circuits operate on 28-volt dc.

Fire and Overheat Warning Lights and Test Switches (Group 70 and Subsequent and Some Earlier Airplanes).

Two red fire warning lights (figure 1-41), one for each engine, are located on the fire extinguishing control panel and will come on when a rapid temperature rise occurs in the engine area. Two amber overheat warning lights (figure 1-41), one for each engine, are located on the fire extinguishing control panel, and will come on when the temperature in the engine bay area rises above 178°C (350°F). A single spring-loaded switch (figure 1-41) with marked L & R FIRE CKT 1 and L OVERHEAT, L & R FIRE CKT 2 and R OVERHEAT positions, and an unmarked OFF position, provides a means of checking the fire and overheat warning circuits. When this switch is held at L & R FIRE CKT 1 and L OVERHEAT, both fire warning lights should come on to indicate that fire warning circuit No. 1 is operative on both engines, and the left overheat warning light should come on to indicate that the overheat detectors in the left engine bay are operative. When the switch is held at L & R FIRE CKT 2 and R OVERHEAT, both left and right fire warning lights again should come on to indicate that fire warning circuit No. 2 is operative, and the right engine overheat warning light should come on to indicate that the overheat detectors in the right engine are operative.

Engine Fire Selector Switches.

Two guarded fire selector switches (figure 1-41), one for each engine, are mounted on the fire extinguishing control panel. These switches are used to turn off the main fuel shutoff valves to the engines and to arm the fire extinguishing agent discharge switch. When the guards over the switches are down, the 28-volt d-c cir-

FIRE EXTINGUISHING SYSTEM

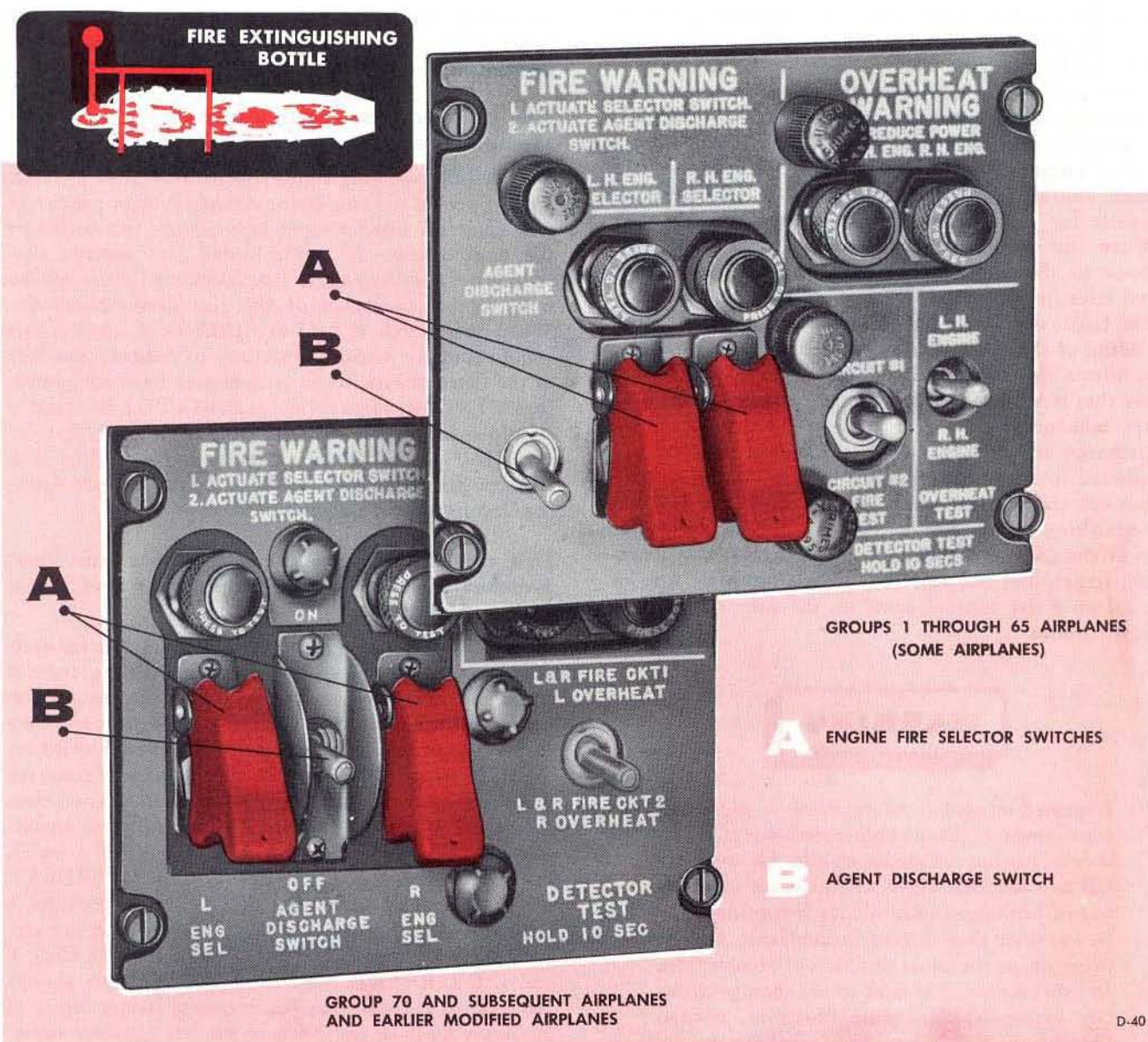


Figure 1-41.

cuits to the agent discharge switch are broken. The guard must be raised and the switch moved up to close the fuel valve for the affected engine and to complete the circuit to the agent discharge switch.

Agent Discharge Switch.

A spring-loaded agent discharge switch (figure 1-41), located on the fire extinguishing control panel, operates the fire extinguisher. When the switch is held momentarily to the UP position, the circuit is closed and current flows to the selected discharge valve on the fire extinguisher bottle. There, a cartridge is fired to

pierce a sealing disk, and the full charge of extinguishing agent is directed to the area surrounding the engine selected by either engine fire selector switch.

CAUTION

The agent discharge switch is ineffective (unarmed) unless one of the engine fire selector switches has been actuated.

CANOPY.

The transparent canopy is operated by an electric motor geared to a chain, and can be controlled normally by any one of three switches: the pilot's, the radar observer's, or the external switch. The canopy motor is powered directly from the battery. In an emergency, the canopy can be fast-jettisoned in flight by either crewmember or slow-jettisoned on the ground by an external emergency release. The canopy travels fore and aft on roller trucks, and is sealed for pressurization by a pneumatic seal that is automatically deflated and inflated by movement of the canopy locks. The seal can also be deflated by depressing the spring button on the seal valve at the left of the pilot's left vertical console. A brake on the actuating motor stops the canopy in any position other than within the forward 10 inches of travel, when the switch is released. When the canopy closes to within approximately 10 inches of the closed position, it trips a microswitch that de-energizes the motor and allows the canopy to coast forward toward the windshield. Just before the canopy strikes the windshield (approximately 1 inch) another microswitch energizes the actuating motor brake momentarily to prevent the canopy from slamming into the windshield. The canopy lock lever is then used to bring the canopy to the locked position. A limit switch also brakes the canopy motor to prevent the canopy from slamming into the rear stops. Group 50 and subsequent and some earlier airplanes have been modified to reduce the impact loads generated by the canopy at its fore and aft limits of travel. The modification consists of installation of two hydraulic shock absorbers, one of which is actuated when the canopy nears the forward limit of travel and the other as the canopy nears the aft limit of travel. Due to the dampening effect on the canopy at both travel limits, impact loads which were formerly imposed on the canopy actuating mechanism and the windshield frame are greatly reduced. This modification also provides the needed braking action when the canopy is operated manually, and the actuating motor brake is inoperative. On some airplanes in Groups 1 through 20 the canopy is free on the tracks when it is between closed position and 10 to 12 inches open. In this range the canopy is held in the tracks by its own weight only. Therefore, it must be closed and locked during taxiing or towing and during high winds. On Group 25 and subsequent airplanes and some earlier airplanes, the canopy track has been modified to retain the canopy at all positions.

Note

Pending compliance with T.O. 1F-89-278, the canopy actuator chain has been removed and the canopy control switches have been made inoperative. This prevents moving the canopy electrically; however, the canopy is free to roll and can be opened and closed manually. While operating the canopy manually,

do not slam the canopy open or closed as damage to the stops may result.

Canopy Jettison System.

In an emergency, the canopy can be fast-jettisoned by either crewmember by raising the ejection seat right armrest, or by the pilot by pulling out (approximately 2 inches) the pilot's canopy jettison "T" handle. The canopy can be slow-jettisoned by the ground crew by pulling out (approximately 5 inches) the external emergency release handle. The radar observer may slow-jettison the canopy by using the emergency hydraulic pump handle to put pressure against the cable attached to the external canopy jettison lever and the canopy jettison initiator. Either method releases compressed gas to the canopy jettison cylinders. When the canopy is fast-jettisoned, the canopy is thrown clear of the airplane. When it is slow-jettisoned, the canopy is slowly pushed above the cockpit rails. From this position the canopy may be pushed or lifted from the airplane.

PILOT'S CANOPY SWITCH.

A slide-type canopy switch (figure 1-42) on the handle of the pilot's canopy lock lever is one of the three spring-loaded switches that control canopy operation. The switch positions are marked OPEN and CLOSE. The switch also has a NEUTRAL position. After the locks have been disengaged, the canopy can be opened by holding the switch at OPEN until the canopy has reached the desired position. When the canopy is opened to its full limit of travel, a limit switch operates a brake to keep the canopy from slamming against the mechanical stops. To close the canopy, the switch is held at CLOSE until the canopy stops moving and the lock lever is then pushed down to close and lock the canopy. The pilot's switch overrides the radar observer's switch, and the external switch overrides both cockpit switches. All canopy switches operate on 28-volt dc from the battery bus.

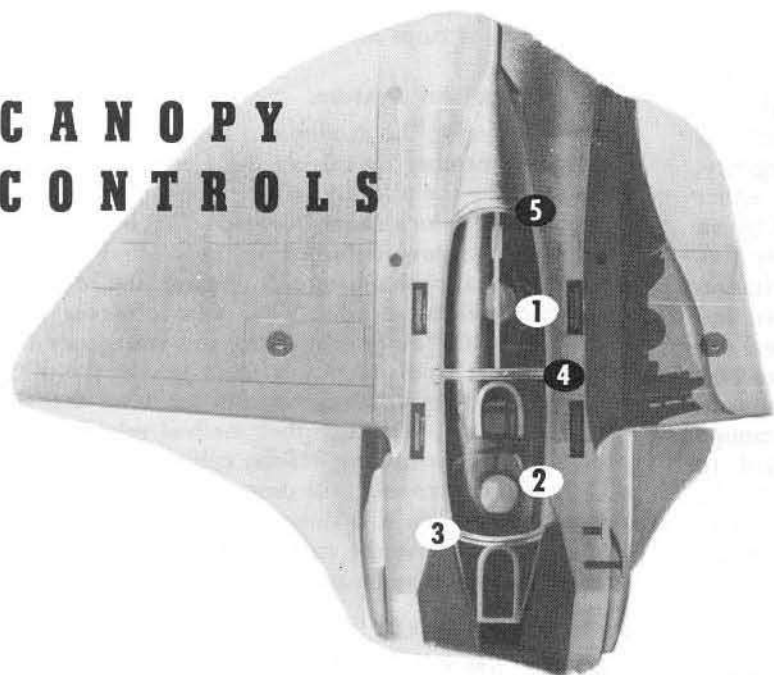
CAUTION

In Groups 1 through 20 airplanes if the canopy is not closed and locked, it is free on the tracks and could fall off when the airplane is taxied over rough ground, or blow off in a crosswind. In Group 25 and subsequent airplanes and some earlier airplanes the canopy may be left open while taxiing up to 50 knots IAS.

RADAR OBSERVER'S CANOPY SWITCH.

A spring-loaded canopy switch (figure 1-42) on the left side of the radar observer's cockpit is marked OPEN and CLOSE, and operates the canopy in the same manner as the pilot's canopy switch.

CANOPY CONTROLS



D-41(1)

EXTERNAL CANOPY SWITCHES.

To permit electrical actuation of the canopy from outside the cockpit, a battery-powered control switch (or switches) (figure 1-42) is located inside a key-locked access door on the left side of the fuselage above the wing leading edge. Some airplanes in Groups 1 through 40 are provided with a single toggle switch with OPEN, CLOSE, and NEUTRAL positions. This switch is spring-loaded to NEUTRAL. When the switch is held in the OPEN or CLOSE position, the canopy moves in the desired direction until the switch is released. Group 45 and subsequent airplanes and some earlier airplanes are provided with two push-type switches: one marked OPEN and one marked CLOSE. When either switch is held depressed, the canopy moves in the desired direction until either the switch is released or the canopy reaches its full limit of travel. On all airplanes the external canopy switch (or switches) overrides the pilot's and radar observer's switches.

WARNING

When opening the canopy with the external canopy switch, use caution to prevent the forward corner of the canopy from striking the operator's hand.

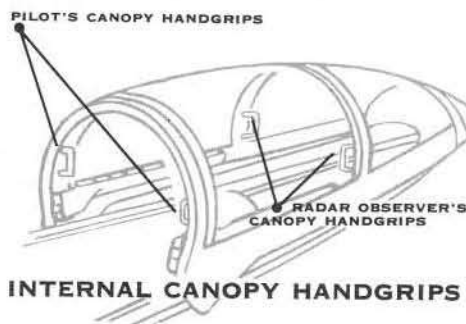


Figure 1-42.

Note

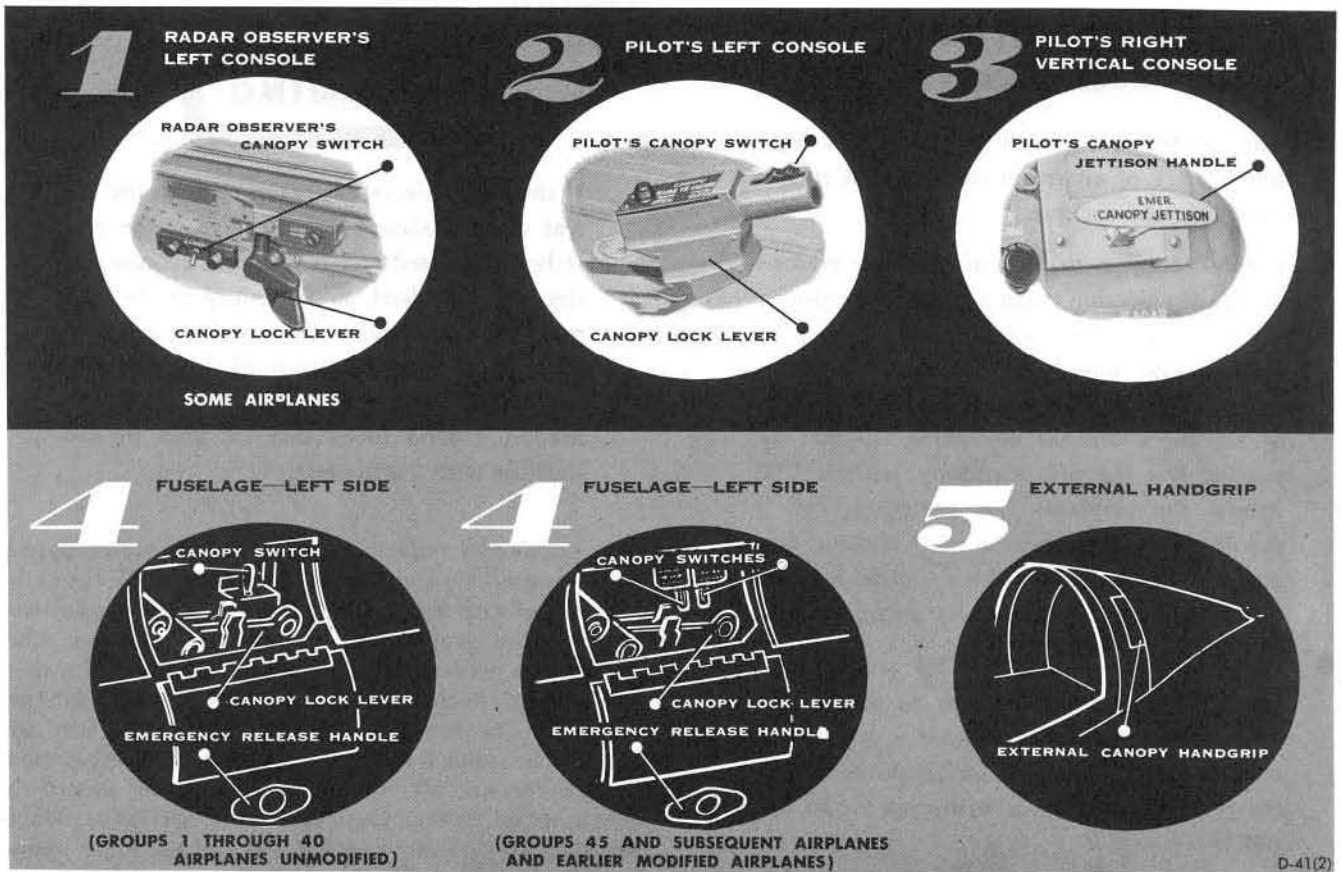
If the canopy cannot be opened by actuating the external canopy switch, push the button on the external emergency handle and then pull the handle. The canopy will be lifted by slow-jettison until it is clear of the tracks.

CANOPY LOCK LEVERS AND INDICATOR LIGHT.

There are three canopy lock levers (figure 1-42): the pilot's, near the floor at the left of the pilot's seat; the radar observer's, on the left side of the cockpit; and the external lever, just below the left cockpit rail inside a key-locked access door. Moving the lock levers forward, when the canopy is within 1 inch of full forward travel, fully closes and locks the canopy and inflates the canopy pressure seal. Pulling the lock levers back releases the locks and a "Canopy Unlocked" 28-volt d-c red indicator light next to the left windshield defogging duct comes on. The light goes out when the locks are engaged. The external lever must be disengaged and pushed into its clip for stowage.

PILOT'S CANOPY HANDGRIPS.

If 28-volt d-c electrical power is not available, the canopy can be opened or closed manually. After release of the canopy locks, the canopy is free to roll. Two handgrips (figure 1-42) on the forward frame of the canopy are for the pilot's use in manual operation.



RADAR OBSERVER'S CANOPY HANDGRIPS.

On Group 50 and subsequent airplanes and some earlier airplanes, the radar observer can move the canopy manually by using U-shaped handgrips (figure 1-42) located on each canopy rail. On some of the earlier airplanes equipped with defogging ducts, the ducts can be used as handgrips.

EXTERNAL CANOPY HANDGRIP.

An external hinged handgrip (figure 1-42), in the aft structure of the canopy, can be used by personnel outside the cockpit to assist in manually moving the canopy.

EXTERNAL EMERGENCY CANOPY RELEASE HANDLE.

The canopy can be slow-jettisoned by an external emergency release handle (figure 1-42) which is flush with the fuselage skin just below the access door for the external canopy switch. A button in the center of the handle must be pressed in to release the handle. Approximately 45 pounds of pull must be exerted to break the safety wire on the jettison valve and a constant pull must be maintained until the canopy breaks free and rises above the cockpit rails. When the handle is pulled out approximately 5 inches and held, compressed gas flows through a restrictor to the actuating

cylinders and, in approximately 10 to 20 seconds, the canopy will be pushed above the cockpit rails. From this position it can be lifted or pushed from the airplane.

WARNING

The canopy should be jettisoned on the ground only in an emergency. To prevent accidental jettisoning of the canopy when the airplane is on the ground, safety pins must be installed in the canopy jettison components in both cockpits (as discussed in Ejection Seat Ground Safety Pins, this section).

EJECTION SEAT RIGHT ARMREST.

The right armrest of either ejection seat (figure 1-43) can be raised to fast-jettison the canopy. When either crewmember raises his right armrest, compressed gas under approximately 1800 psi flows to the actuating cylinders, the canopy locks release, and the canopy is thrown into the air.

WARNING

- The canopy goes straight up when it is jettisoned. Lack of airstream may cause it to fall back into the cockpit.
- If the canopy is to be jettisoned for reasons other than ejection (such as a forced landing), the pilot should not use the seat armrest, as this will also cause his seat to bottom, thus restricting vision. The canopy can be jettisoned by the pilot without bottoming the seat by pulling out the pilot's canopy jettison "T" handle. On airplanes not equipped with a canopy jettison handle, the radar observer can jettison the canopy without bottoming the pilot's seat by raising either armrest.
- Keep hands and arms clear of canopy lock levers during canopy jettison. As the canopy is jettisoned the radar observer's lock lever will rotate rapidly to the OPEN position, and the pilot's control lever will snap to the UP (OPEN) position.

PILOT'S CANOPY JETTISON "T" HANDLE.

On Group 35 and subsequent airplanes and some earlier airplanes, a "T" handle (figure 1-12), located on the pilot's right vertical console, enables the pilot to fast-jettison the canopy without using the ejection seat control. This handle is linked by a cable to a gas initiator located on the floor just forward of the right console. The cable also is linked to a microswitch in the 28-volt d-c circuit to the canopy retention solenoids. Pulling the handle out approximately 1 inch opens the microswitch and interrupts the circuit to the canopy retention solenoids; pulling the handle another inch (a total of approximately 2 inches) draws the firing pin from the initiator which in turn opens the shutoff valve to the canopy jettison cylinders. On Group 35 and subsequent airplanes, the retraction mechanism for stowing the radar observer's scope and console is then automatically actuated to the stowed position. The jettison cylinders then release the canopy locks and throw the canopy from the airplane. The pilot's canopy jettison "T" handle should be used for all emergencies, other than ejection, requiring jettisoning of the canopy. To prevent inadvertent canopy jettisoning, a ground safety pin is provided for the canopy jettison gas initiator. This pin with its streamer is attached to the end of the pilot's ejection seat ground safety pin streamer.

EJECTION SEATS.**WARNING**

If the C-2A life raft is being carried, the A-5 seat cushion should not be left on the seat. If both are used and it becomes necessary to eject or crash land, severe injury to the back may result because of the excessive compressibility of the combination of life raft and cushion. If additional height in the seat is needed, a solid block may be used in conjunction with the life raft.

The pilot's and radar observer's stations are equipped with catapult-type ejection seats (figure 1-43). A catapult aft of each seat contains an explosive charge that supplies the propelling force for seat ejection. The catapult is permanently safetied by two shear pins that are sheared during firing by gas pressure from an initiator. The headrest and footrests of each seat are fixed. The pilot's seat is adjustable in combination vertical-fore-and-aft directions. The radar observer's seat is not adjustable. Controls for the ejection sequence are the two armrests on each seat and the right hand-grip firing trigger. Movement of these controls actuates a compressed air system that automatically lowers the pilot's seat to the full down position, locks the shoulder harness inertia reel, fires the gas initiators which actuate the components that jettison the canopy, stows the radar observer's scope, and fires the catapult. As the seat is ejected, anti "G" suit, oxygen hose, microphone, and headset connections automatically disconnect at the seat. For ejection, the canopy can be jettisoned by either the pilot or radar observer, but seat ejection is controlled by the individual occupying the seat.

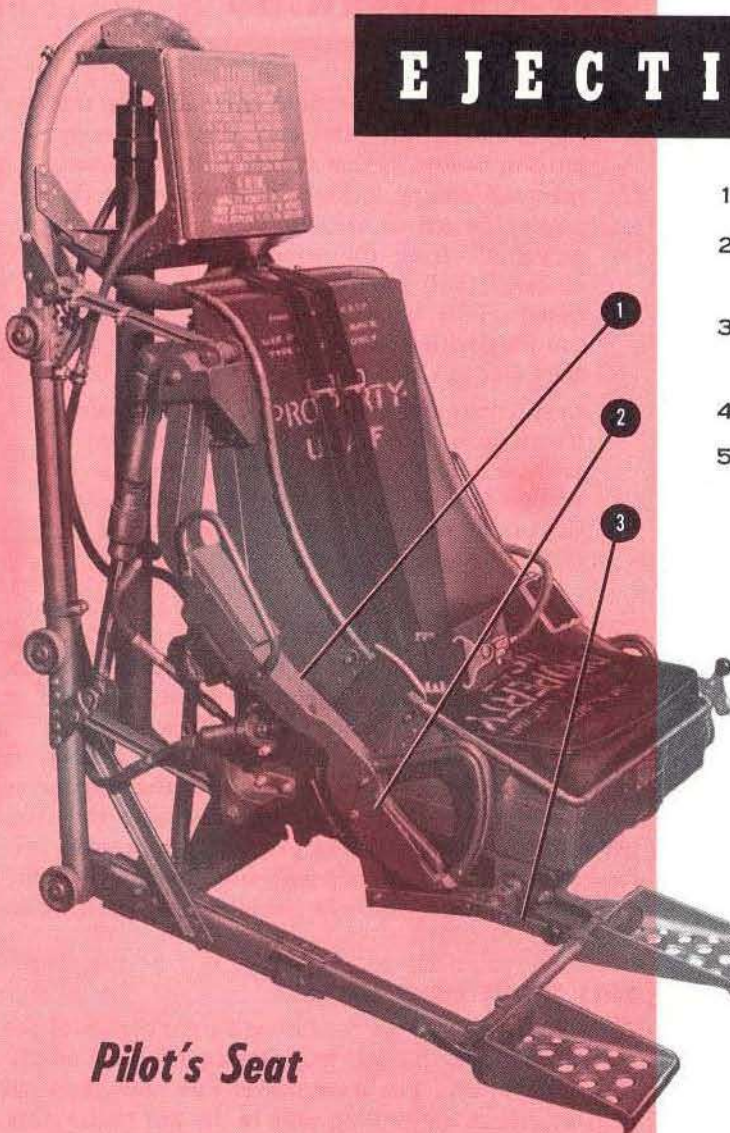
Note

Actuation of either the pilot's or radar observer's right armrest will jettison the canopy and stow the radar scope.

WARNING

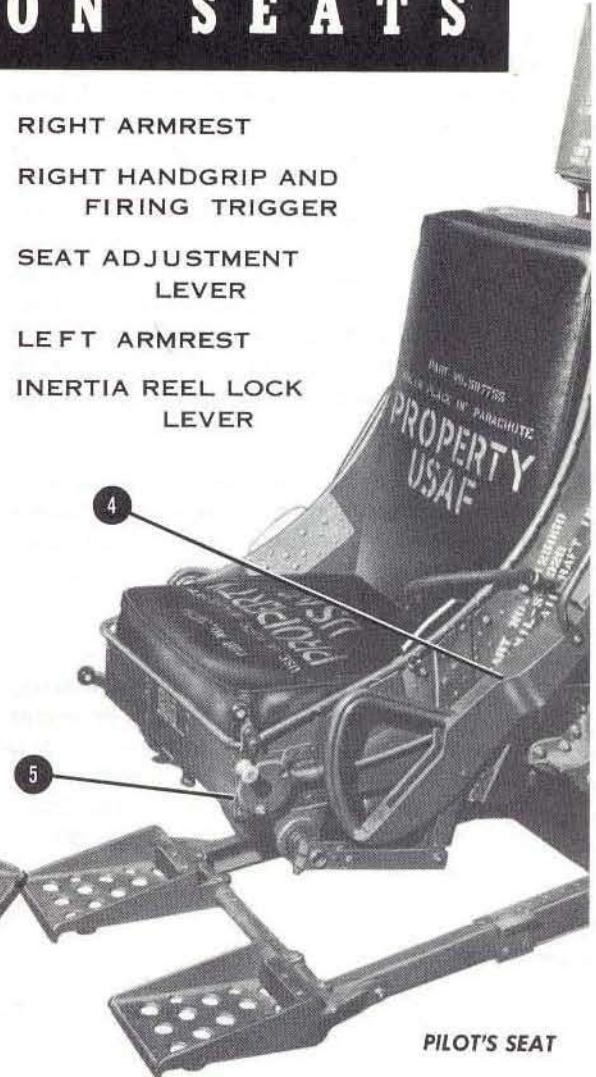
If time and conditions permit, the radar observer rather than the pilot should jettison the canopy. This will assure that the radar observer is in position for ejection and will have no difficulty in reaching the ejection seat controls due to wind blast or "G" forces.

EJECTION SEATS



Pilot's Seat

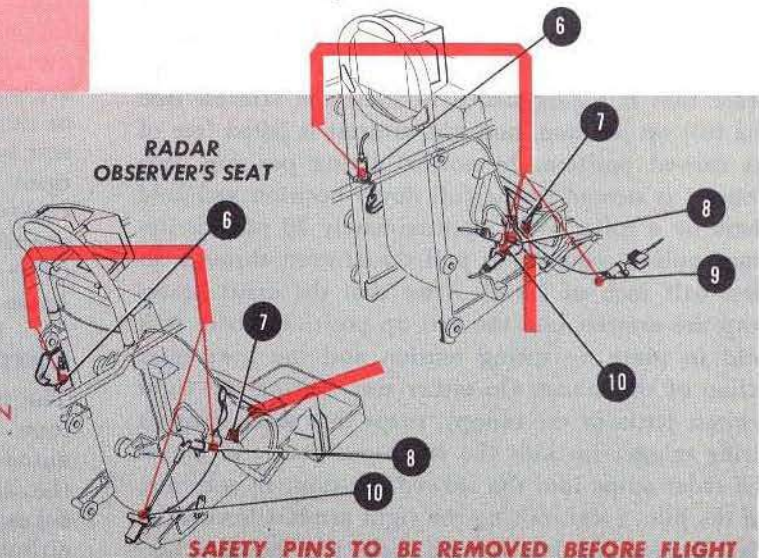
- 1 RIGHT ARMREST
- 2 RIGHT HANDGRIP AND FIRING TRIGGER
- 3 SEAT ADJUSTMENT LEVER
- 4 LEFT ARMREST
- 5 INERTIA REEL LOCK LEVER



PILOT'S SEAT

Seat Safety Pins...

- 6 SAFETY BELT RELEASE INITIATOR PIN
- 7 RIGHT ARMREST GROUND SAFETY PIN
- 8 CATAPULT FIRING INITIATOR PIN
- 9 EMERGENCY CANOPY JETTISON INITIATOR PIN
- 10 CANOPY JETTISON INITIATOR PIN



SAFETY PINS TO BE REMOVED BEFORE FLIGHT

D-42

Figure 1-43.

WARNING

- If raising the right armrest or pulling the pilot's canopy jettison "T" handle does not jettison the canopy, raise the canopy lock lever and move the canopy switch to OPEN. When the canopy moves aft from the windshield frame, it will be free on the tracks and the airstream will blow it from the fuselage. (On Group 25 and subsequent airplanes that have the canopy retention feature, raising the armrest releases the canopy retention bars.) If the canopy fails to blow off when the lock lever and the canopy switch are used, continue with normal ejection procedure and eject through the canopy.
- Keep hands and arms clear of canopy lock levers during canopy jettison. As the canopy is jettisoned the radar observer's lock lever will rotate rapidly to the OPEN position, and the pilot's lock lever will snap to the up (OPEN) position.
- If the seat is equipped with an automatic safety belt, the belt releases automatically by means of gas pressure from a delay initiator which is fired as the seat is ejected and which allows approximately 2 seconds more for the seat to clear the airplane before the safety belt is released.

ARMRESTS.

The right and left armrests (figure 1-43) are not interconnected and may be moved independently of each other. Each armrest terminates in a loop-type handgrip, the right handgrip containing the catapult firing trigger. Each armrest is fitted with a jackknife-type brace that is spring-loaded to assist the armrest into the full up position, once the armrest is lifted free of its stowed position. In normal flying position each armrest is stowed in the full down position and held there by a roller lock. Approximately 20 pounds upward pull is required to pull the armrest through its first half inch of travel. After that the assist braces snap the armrest into the full up position where it is held in place by spring tension and the overcenter action of the braces. On either seat, raising the right armrest jettisons the canopy, snaps that seat's catapult firing trigger up into the ready position, and moves the radar scope into the stowed position; in addition, on the pilot's seat, raising the right armrest lowers the seat. Raising the left armrest locks the shoulder harness inertia reel.

WARNING

- If canopy fails to jettison after raising the right armrest, the pilot may pull the canopy jettison handle. If that system fails to operate, raise the canopy locking lever and move the canopy switch to OPEN. When the canopy moves aft from the windshield frame, the airstream will blow it from the fuselage. If canopy fails to blow off when unlocked, continue with normal ejection procedure and eject through the canopy.
- Keep hands and arms clear of canopy control levers during canopy jettison. As the canopy is jettisoned the radar observer's control lever will rotate rapidly to the OPEN position, and the pilot's control lever will snap to the up (OPEN) position.

CATAPULT FIRING TRIGGER.

The catapult firing trigger (figure 1-43), located in the loop-type handgrip of the right armrest, is locked in the stowed position when the armrest is down in normal flying position. When the right armrest is raised, the trigger lock releases and the trigger is snapped up into firing position. Squeezing the trigger pulls the initiator firing pin, and gas pressure sufficient to shear the permanent safety pins drives the catapult firing pin into the detonator to fire the seat catapult.

SEAT ADJUSTMENT LEVER.

A lever (figure 1-43) at the forward right corner of the seat bucket controls locking pins in the seat adjustment mechanism. The lever moves fore and aft to engage or retract the locking pins in the seat positioning struts aft of the seat bucket. When the lever is full forward, the seat is locked in place. When the lever is moved aft approximately 15 degrees, the locking pins are withdrawn and the seat may be adjusted upward or downward by relieving or applying weight to the seat bucket. Lift pressure for seat adjustment is developed by a spring-loaded "A" frame attached to the cockpit floor. A roller at the top of the "A" frame exerts an upward pressure of approximately 93 pounds (over and above the weight of the empty seat) against a guide track on the bottom of the seat bucket.

SAFETY BELT AUTOMATIC RELEASE.

The primary purpose of the safety belt automatic release (figure 1-44), particularly when used with an automatic-opening aneroid-type parachute, is to extend the maximum and minimum altitudes at which successful escape can be made using the ejection seat. In a high altitude ejection (above 15,000 feet), the automatic system delays deployment of the parachute until an

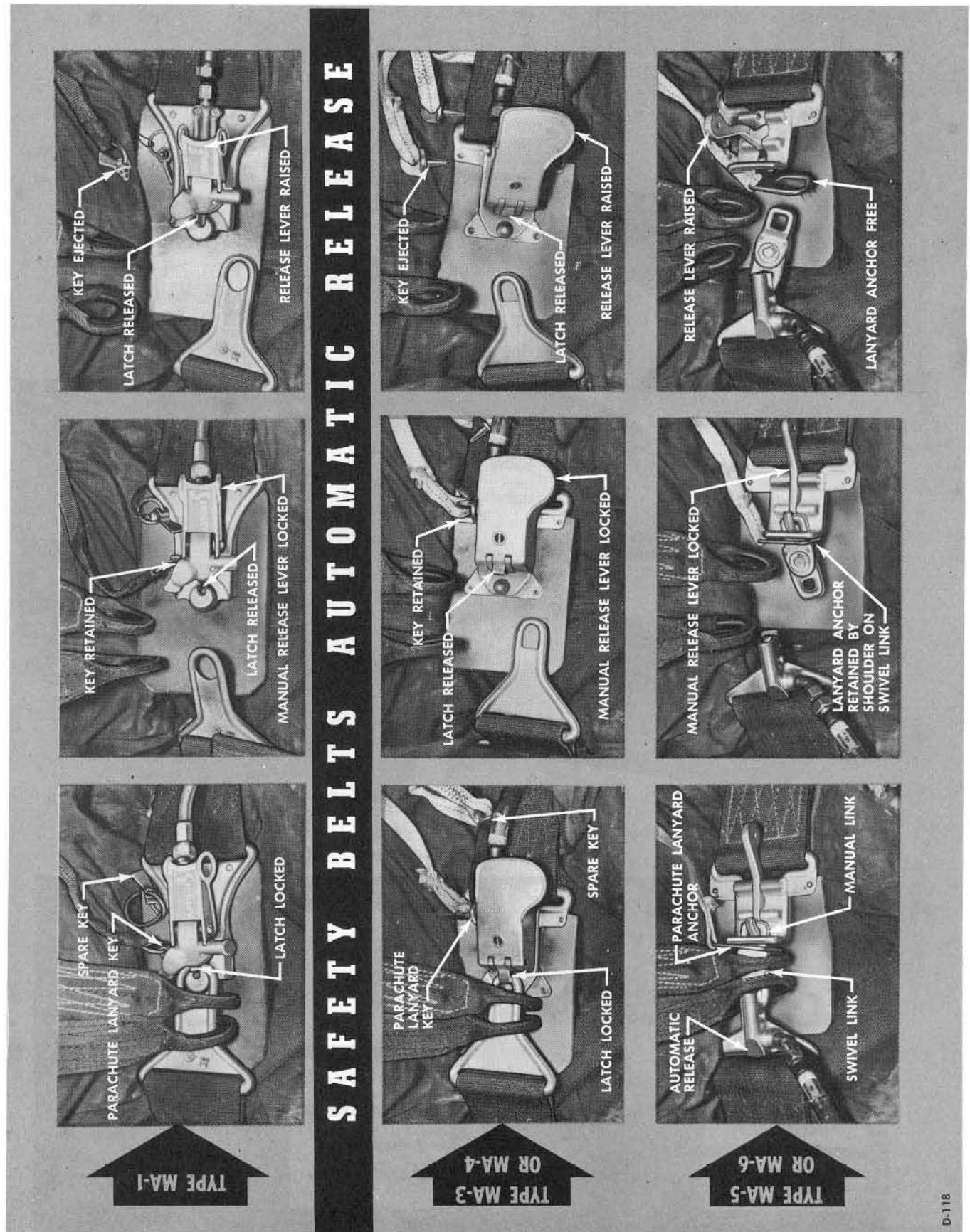
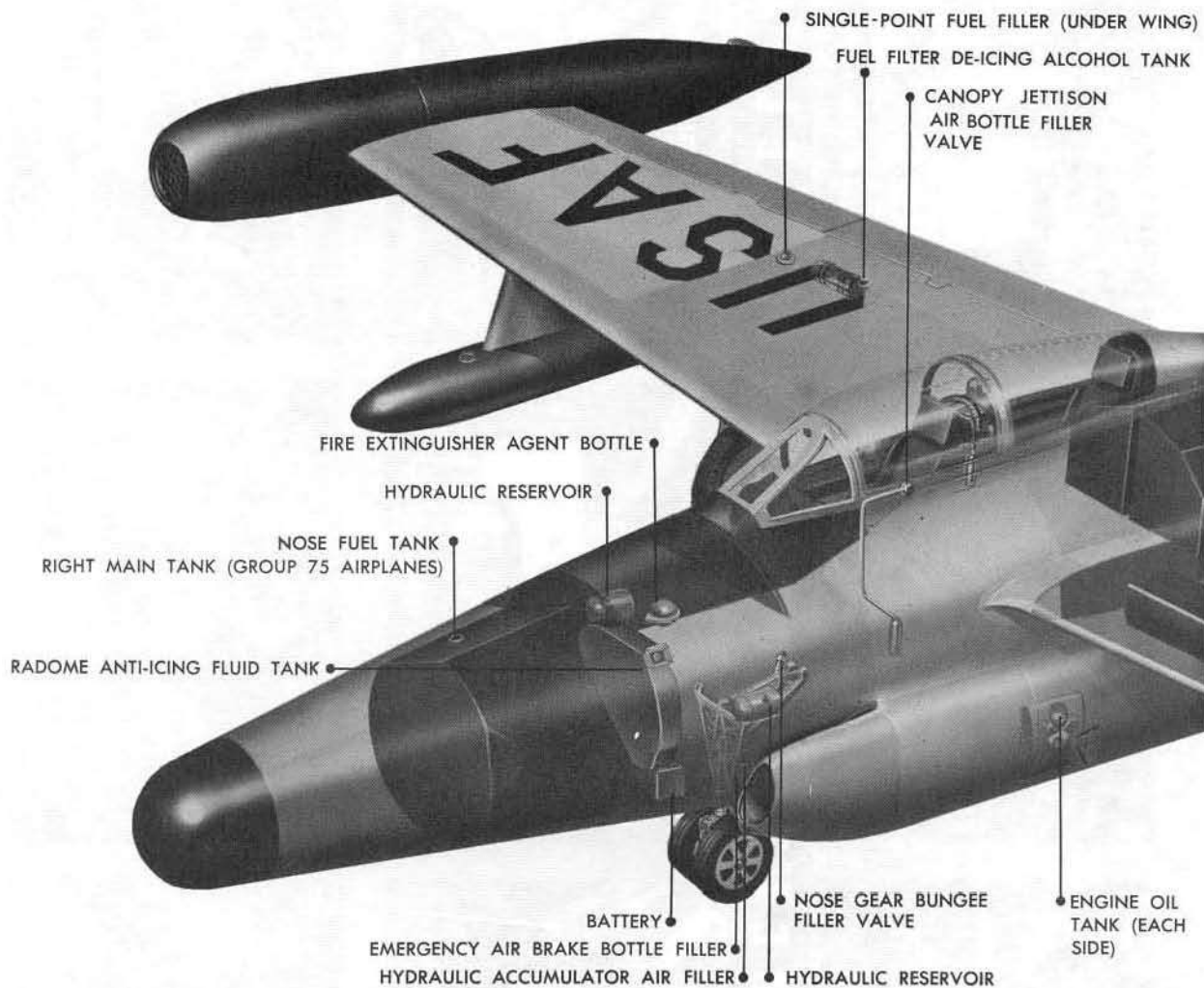


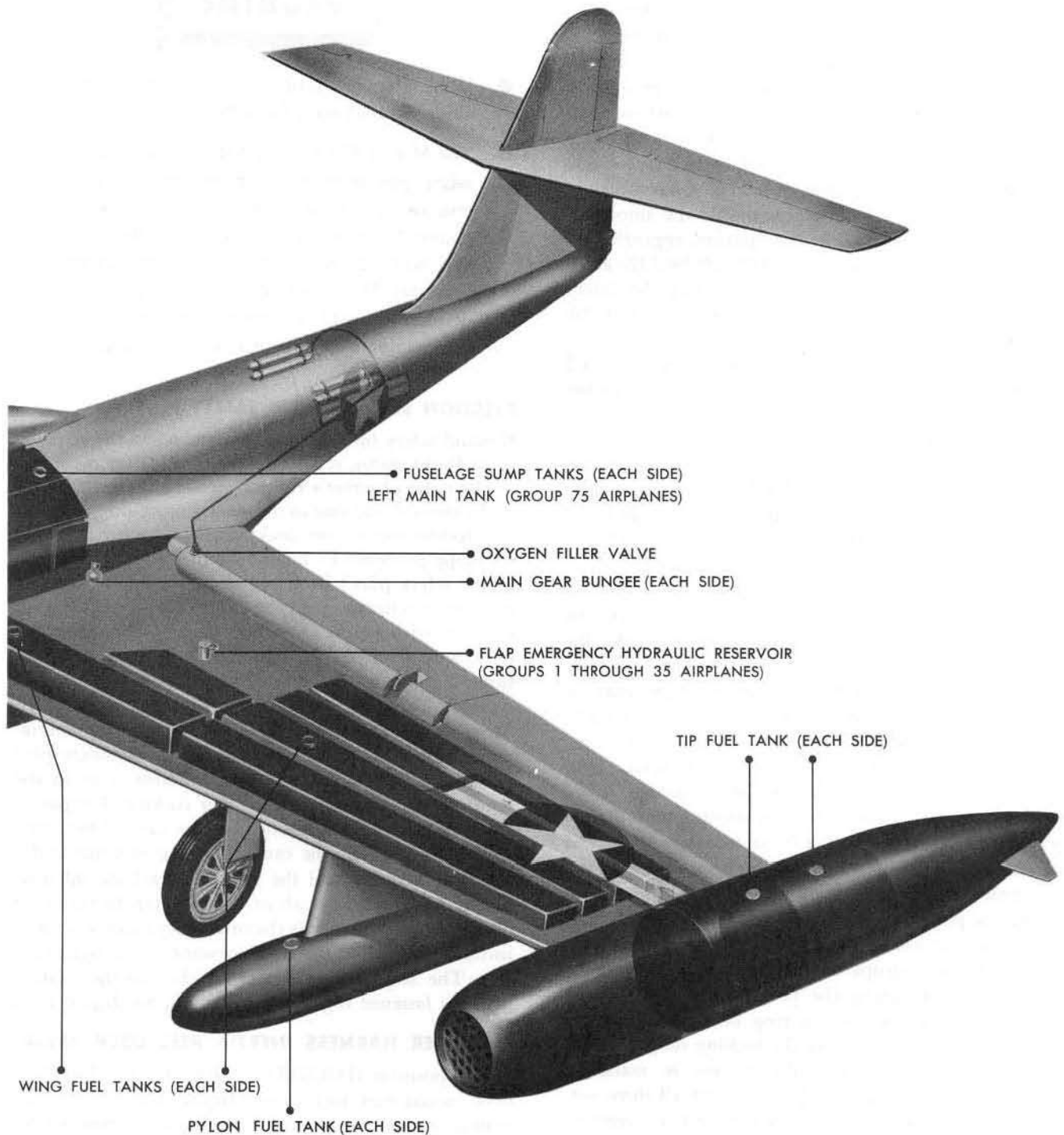
Figure 1-44.



FLUID SPECIFICATIONS

● FUEL SPECIFICATIONS	RECOMMENDED MIL-F-5624A GRADE JP-4 ALTERNATE MIL-F-5572 ANY GRADE	● RADOME ANTI-ICING FLUID SPECIFICATION (BY VOLUME)	60% ETHYLENE GLYCOL (MIL-E-9500) 40% DISTILLED WATER 0.1% WETTING AGENT (MIL-D-16791B)
● ENGINE OIL SPECIFICATION	MIL-O-6081 GRADE 1010	● ALCOHOL SPECIFICATION	MIL-A-6091
● HYDRAULIC FLUID SPECIFICATION	MIL-O-5606	● FIRE EXTINGUISHING AGENT SPECIFICATION	BROMOCHLOROMETHANE (MIL-B-4394)
● OXYGEN SPECIFICATION	MIL-BB-O-925		

Figure 1-45.



SERVICING DIAGRAM

altitude is reached where sufficient oxygen is available to permit a safe parachute descent and air density is great enough to reduce parachute opening shock. In a low altitude ejection, use of the automatic system greatly reduces the overall time required for separation from the seat and deployment of the parachute, and consequently reduces the altitude required for safe ejection. The various types of safety belt automatic releases have been thoroughly tested and are completely reliable. Under no circumstances should the automatic belt be manually opened before ejection, regardless of altitude. Human reaction cannot possibly beat the automatic operation of the release in opening the safety belt and arming the parachute, particularly under the stresses imposed by escape. The escape operation using the automatic release is not only faster, since it opens 2 seconds after ejection, but also protects the crewmember from severe injury at high speeds. Because the deceleration of a crewmember alone is considerably greater than that of the crewmember and seat together, immediate separation would result if the belt were manually opened just before ejection. This would not only cause greater "G" forces during deceleration, but could result in the parachute pack being blown open. The high opening shock of the parachute under these conditions could cause fatal injuries. Currently, three types of safety belt automatic releases are in general use, the MA-1, the MA-2, -3, and -4, and the MA-5 and -6. (See figure 1-44.) Any of these various types may be found in the airplane. All three releases are designed to be locked and opened manually under normal usage, much the same as the standard manual safety belt, except that on the MA-1 through MA-4 models, a key that is attached to the parachute lanyard must be inserted into the release before it can be manually locked to insure that the crewmember does not overlook the attachment of his chute lanyard to the release. (If an automatic parachute is not used, the key attached to the release is used.) When the release is manually opened, the key drops out of the release to prevent inadvertently dumping the parachute. On the MA-5 and -6 automatic releases, a ring on the end of the parachute lanyard slips over the locking tongue of the release mechanism; when the release is manually opened, the ring slips free. However, on all three versions of the automatic release, the key (or ring) remains attached to the mechanism when the release is forced apart by gas pressure following an ejection, thus actuating the parachute mechanism when the crewmember separates from his seat. Manual operation of the system can override the automatic features at any time. For example, it is possible to open the safety belt manually even though initiator action has started. The parachute automatic features may also be overridden by manual operation even though the automatic parachute rip cord release has been actuated.

WARNING

- If the safety belt is opened manually, the parachute rip cord must be pulled manually.
- The M-4 or M-12 safety belt initiator ground safety pin with warning streamer must be removed prior to flight. If the pin is not removed, automatic uncoupling of the safety belt will not occur should ejection become necessary. If the pin is installed, maintenance personnel should be consulted on the status of the ejection system before occupying the seat.

EJECTION SEAT GROUND SAFETY PINS.

Ground safety for the ejection seats, when the airplane is on flight status, is afforded by three safety pins: one in the radar observer's right armrest; one in the pilot's right armrest, and one in the emergency canopy jettison "T" handle in the front cockpit. (On Group 5 airplanes a canopy jettison "T" handle guard is used in addition to the safety pins.) Each pin is attached to a streamer and the two streamers in the front cockpit are fastened together with straps. These pins (and "T" handle guard on Group 5 airplanes) must be removed just before taxiing and must be replaced before the safety belts are opened. The pins must remain in the cockpit at all times. Ground safety for ejection seats, during maintenance operation, is achieved by additional safety pins which are installed in each gas initiator, four in the front cockpit and three in the rear cockpit. The points to be safetied in each cockpit are the canopy fast jettison valve initiator, the catapult firing initiator under the right armrest, and the safety belt release initiator on the left seat frame, aft of the backrest. In the front cockpit, a fourth point is the emergency canopy jettison initiator located on the floor forward of the right console. The large red streamers attached to these safety pins are fastened together with snaps. See figure 1-43.

SHOULDER HARNESS INERTIA REEL LOCK LEVER.

A two-position (LOCKED—UNLOCK) shoulder harness inertia reel lock lever (figure 1-43) is used to manually lock the shoulder harness reel or leave it free, subject to the inertia lock. The lever is located on the left side of each ejection seat. The lever is held in position by a friction disk and may be moved by a firm pressure forward to lock, or aft to unlock, the inertia reel. When the lever is in the UNLOCK position (all airplanes), the reel harness cable will extend to allow the pilot to lean forward in the cockpit; however, the inertia reel will automatically lock the shoulder harness tension cable when an impact force of two to three "G's" is encountered. When the reel is locked in this

manner, it will remain locked until the lever is moved to the LOCKED position and then returned to the UNLOCK position. When the lever is in the LOCKED position, the reel harness cable is manually locked so that the pilot is prevented from bending forward. The LOCKED position provides an added safety precaution over and above that of the automatic inertia-operated safety lock. The reel will also lock automatically when the left armrest is raised prior to seat ejection.

AUXILIARY EQUIPMENT.

Section IV of this handbook describes the following auxiliary equipment and its operation: cabin air conditioning system, canopy defogging system, anti-icing systems, communication and associated electronic equipment, lighting equipment, oxygen system, autopilot, armament, single-point fueling system, and miscellaneous equipment.



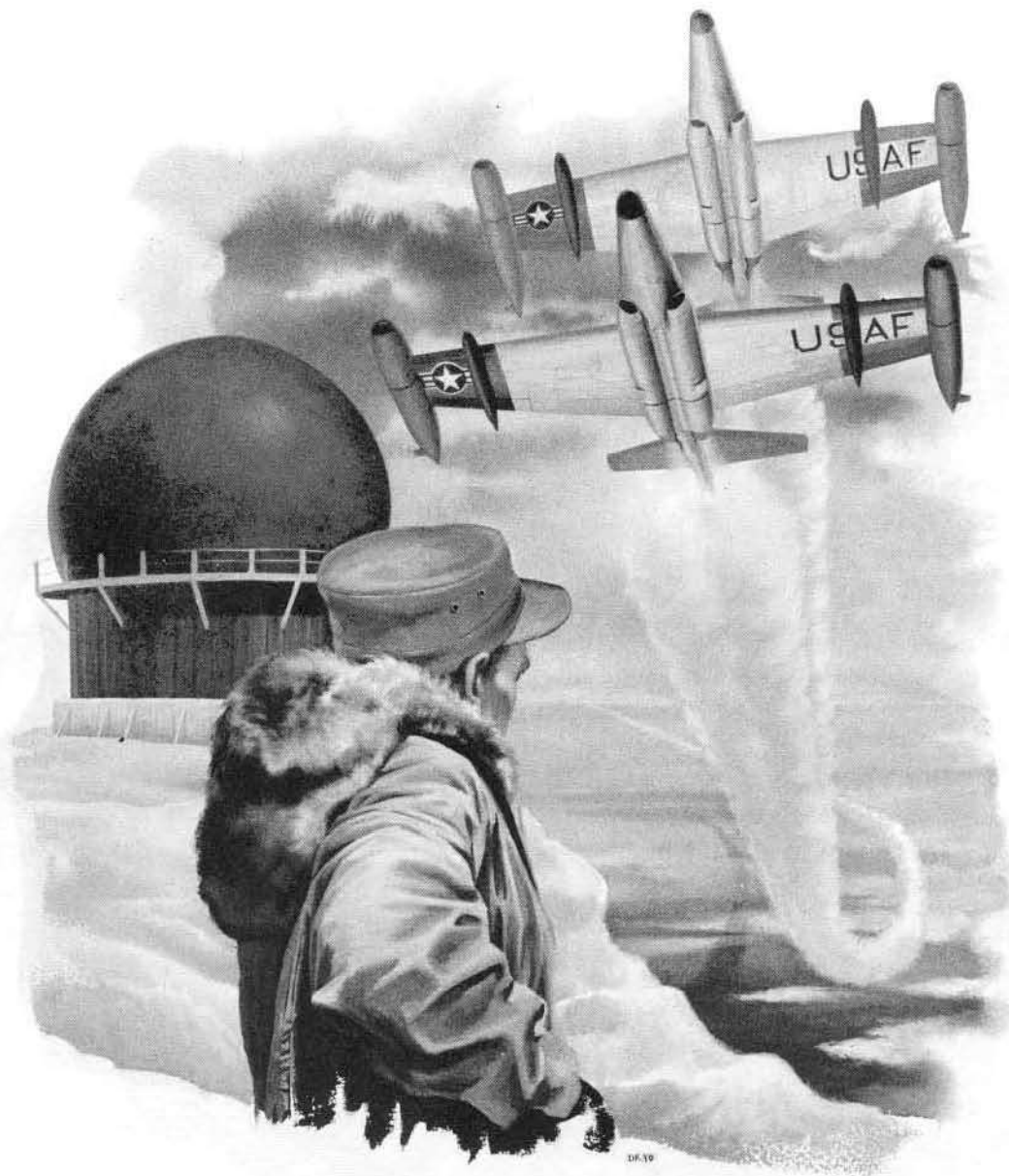




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Procedure steps in this section are followed by the symbols P, RO, or P—RO in parentheses to indicate whether the particular step is applicable to the pilot, radar observer, or both crewmembers.

STATUS OF THE AIRPLANE.

FLIGHT RESTRICTIONS.

Refer to Section V, Operating Limitations, for restrictions and limitations.

FLIGHT PLANNING.

Prepare a complete flight plan to determine the required fuel, oil, oxygen, airspeed, power settings, and other items for the proposed mission. Use the operating data in Appendix I to assist you in planning.

WEIGHT AND BALANCE.

1. Check takeoff and anticipated landing gross weights and balance.
2. Make sure the airplane has been serviced and that the required armament and special equipment are loaded.
3. Refer to Section V for weight limitations.
4. Refer to Handbooks of Weight and Balance Data, T.O. 1-1B-40 and T.O. 1F-89D-5, for detailed loading information.
5. Check that the weight and balance clearance, DD Form 365 F, is satisfactory.

ENTRANCE.

For the proper method of entering this airplane, refer to figure 2-1.

BEFORE EXTERIOR INSPECTION.

Check DD Form 781 for the status of the airplane; make sure that the airplane has been properly serviced.

EXTERIOR INSPECTION.

Conduct the exterior inspection as shown in figure 2-2.

CAUTION

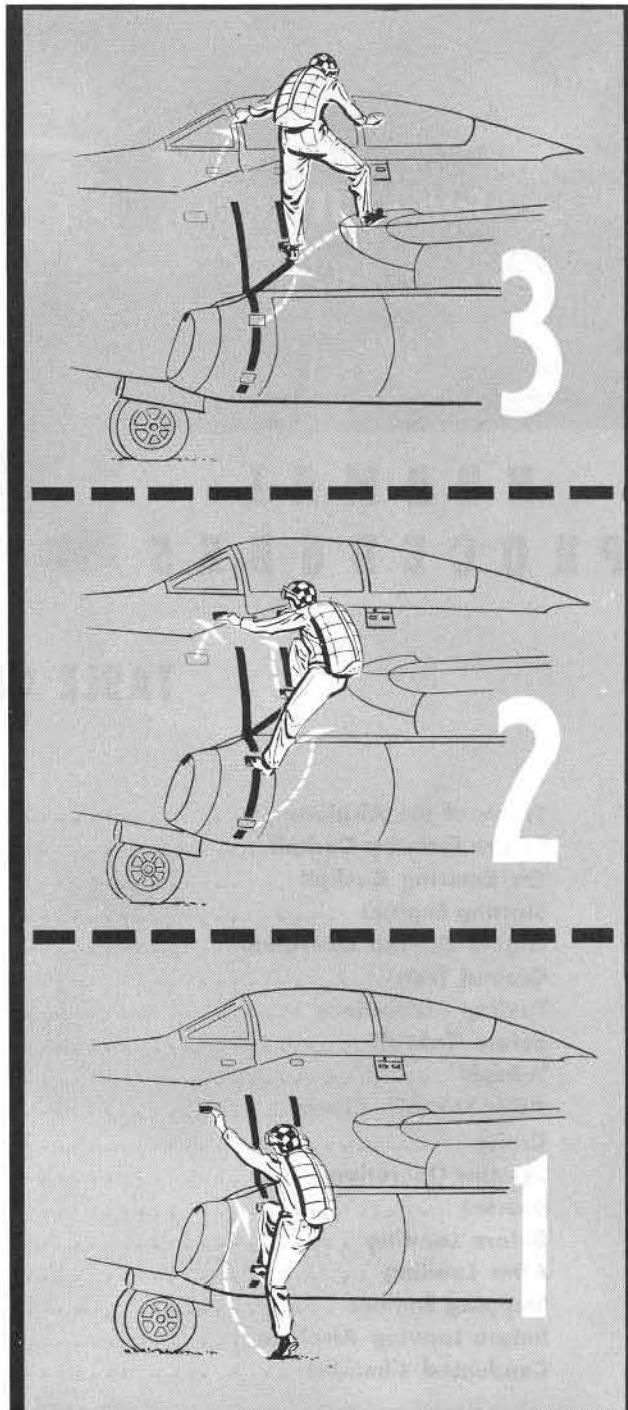
Locate external power unit as far from the airplane as the power cable will permit, to reduce the hazard of fire from exhaust gas or hot components of the power unit.

BEFORE ENTERING COCKPIT.

1. Ejection seats—Check. (P—RO)
Armrests and trigger stowed; safety belt initiator ground safety pin removed; safety pins installed; seat air bottle pressure 1600 to 1800 psi; catapult file mark aligned.

Note

If the safety belt initiator ground safety pin is installed, consult maintenance personnel regarding the status of the ejection system before occupying the ejection seat.



E N T R A N C E

THE COCKPIT IS ENTERED FROM THE LEFT SIDE OF THE AIRPLANE FORWARD OF THE WING. KICK-IN STEPS AND HANDGRIPS ARE ON THE LEFT SIDE OF THE FUSELAGE AND ENGINE AIR INTAKE DUCT. THE CANOPY IS UNLOCKED MANUALLY AND OPENED BY THE EXTERNAL CANOPY SWITCH INSIDE AN ACCESS DOOR ABOVE THE WING LEADING EDGE.

D-44

Figure 2-1.

2. Canopy ejector pressure—Check. (P—RO)
3. Armament safety control switch—OFF. (P)

ON ENTERING COCKPIT.

Note

A pilot's checklist (figure 1-10) is located above the center pedestal.

INTERIOR CHECK.

WARNING

If the C-2A life raft is being carried, the A-5 seat cushion should not be left on the seat. If both are used and it becomes necessary to eject or crash land, severe injury to the back may be caused by the excessive compressibility of the combination of life raft and cushion. If additional height in the seat is needed, a solid filler block may be used in conjunction with the life raft.

1. Safety belt and shoulder harness—Fasten; inertia reel operation—Check; automatic-opening parachute lanyard—Connected. (P—RO)
2. Rudder pedals—Adjust. (P)
3. Battery switch—OFF. (P)
4. 28-volt external power—Have connected (on right intake duct). (P)

Note

On Group 25 and subsequent airplanes equipped with J35-35 engines, if more than 15 minutes are to elapse between supplying power to the 28-volt d-c bus and starting or operating engines above idle rpm, pull out the afterburner control circuit breakers (on Group 75 airplanes move afterburner control switches to the un placarded OFF position) and leave them off until just before starting engines. This will deenergize the eyelid control solenoids, thus preventing them from being damaged by overheating.

5. Instrument inverter switch (Groups 1 through 30 airplanes)—Check SPARE and MAIN—(Leave on MAIN). (P)

6. Power inverter switch (Groups 1 through 30 airplanes)—Check SPARE and MAIN—(Leave on MAIN). (P)

7. Three-phase inverter switch (Group 35 and subsequent airplanes)—Check SPARE and MAIN—(Leave on MAIN). (P)

8. Single-phase inverter switch (Group 35 and subsequent airplanes)—Check EMERGENCY and NORMAL—(Leave on NORMAL). (P)

Radar observer check three voltages. (RO)

9. Left console circuit breakers—IN. (P)

10. Emergency airbrake valve handle—OFF. (P)

11. Sideslip stability augments switch—ON; rudder trim switch (Group 50 and subsequent airplanes)—AUTO TRIM. (P)

12. Single-point fueling light—OUT. (P)

13. Fuel control panel and fuel gages—Check. (P)

Crossfeed switch—OFF; wing tank, tip tank, and pylon tank switches—ON (if full); fuel selector switches—WING TANKS (inboard and outboard tank lights should flash). Fuel selector switches—NOSE TANK (Groups 1 through 70 airplanes). Nose tank lights should flash. Fuel selector switches—ALL TANKS: check fuel quantity gages. Move gage selector switch to each position, note readings on right and left indicators, then turn gage selector switch to ALL TANKS (SUMP, Groups 1 through 70 airplanes).

14. Emergency flight control switch—ON, or nose wheel steering button—Depress. (P)

Depends upon whether airplane is equipped with right hydraulic system emergency flight control pump or left hydraulic system supplemental pump. Check that right hydraulic pressure builds up to 1500 psi or left hydraulic pressure builds up to 2500 psi.

15. Operate all flight controls simultaneously. (P)

Visually check control surface operation. On airplanes having a right hydraulic system emergency pump, hydraulic pressure should remain above 700 psi while actuating all flight controls.

16. Aileron and elevator trim switch—Check. (P)

Move the switch full travel to left, right, fore, and aft positions to make sure that the switch automatically returns to neutral when released. If the switch sticks in any one of the positions, enter this fact with a red cross on DD Form 781 and do not fly the airplane. During the check, stick force should be exerted against the trim to assure that trim can be overpowered. Return the elevator trim to the TAKEOFF position when check is completed. Check control stick grip for security.

CAUTION

In checking the control stick grip do not twist the grip as such action may cause the grip to become less secure.

EXTERIOR INSPECTION

When approaching the airplane, note the general overall appearance and then check the following items:

A LEFT FORWARD SIDE

1. Pitot tube, static vents and probe clear.
2. Hydraulic fluid and radome anti-icing fluid levels checked; caps secured.
3. Nose wheel tires for condition, inflation and slippage.
4. Nose wheel door condition.
5. Nose wheel strut extension (approximately three inches); ground lock removed.
6. Static ground contact.
7. Fire extinguishing agent and bungee air pressures.
8. Landing-taxi lights condition.
9. Battery access door secured.
10. All access doors secured.
11. Radar nose condition; anti-icing nozzle clear.

B RIGHT FORWARD SIDE

12. All access doors secured, nose tank filler cap secured (some airplanes).
13. Hydraulic fluid level checked; cap secured.
14. Pitot tube and static vents clear.
15. Cabin pressure regulator outlet clear.
16. Engine intake duct clear; screens and compressor blades aligned and undamaged. Check ground for foreign objects.
17. Evidence of fuel, oil, and hydraulic leaks.
18. Engine doors secured.
19. Engine air intake doors free.
20. Check oil quantity; oil filler cap secured.
21. Eleventh-stage compressor bleed port clear.
22. Engine door No. 3 air scoop clear; inside door No. 3 air scoop, check for chafed fuel line. Engine door No. 4 air scoop clear (later airplanes).

C RIGHT WING

23. Wheel chocks in place; ground lock removed.
24. Tire condition, inflation, and slippage.
25. Brake disc for condition, pucks for proper clearance, and brake shuttle valve checked.
26. Jack lug pointing straight downward.
27. Landing gear outboard door condition; strut extension (approximately six inches between torque arm pivot points) and check outboard door locking arm for tension.
28. Wheel well lines for condition and leaks.
29. Inboard main gear door closed and locked.
30. Bungee air pressure.
31. Sequence valve transfer piston for condition and position (out), so that landing gear and door will sequence properly.
32. Gear uplock unlocked and roller free.
33. Wing leading edge condition.

34. Underside of wing for condition, fuel leaks, and hydraulic leaks; tiedown ring flush, and fuel tank vent outlets free of obstructions.
35. Single-point refueling cap secured, refueling door locked.
36. Pylon tank pressure release valve closed.
37. Pylon tank filler cap secured.
38. Pylon vent port clear.
39. Pylon and tank for condition and leaks.
40. Pylon tank sway braces secured.
41. Wing access doors secured.
42. Anti-icing overboard duct clear.
43. Tip tank access doors secured.
44. Position light condition.
45. Tip pod fin attachment.
46. Tip tank vent and fuel dump port clear.
47. Aileron and wing flap for condition and hydraulic leaks, aileron neutral, wing flap up. Speed brake external ground lock removed.

D RIGHT AFT FUSELAGE

48. Tailpipe, fuel manifold, and flameholder condition.
49. Eyelids condition and position: closed, J35-47 engines; open, J35-35 engines.
50. Afterburner blast plate condition.
51. Refrigerator air intake and exhaust clear.
52. Aft fuselage access doors secured.
53. Fuselage position lights condition.

E EMPENNAGE

54. General condition.
55. Drain ports for hydraulic leaks.
56. Position lights condition.
57. Access doors secured.
58. Rudder for approximate neutral position.

F LEFT AFT FUSELAGE

59. Oxygen filler door secured.
60. Tailpipe, fuel manifold, and flameholder condition.
61. Eyelids condition and position: closed J35-47 engines; open, J35-35 engines.
62. Afterburner blast plate condition.

G LEFT WING

63. Aileron and wing flap for condition and hydraulic leaks, aileron neutral, wing flap up. Speed brake external ground lock removed.
64. Tip tank fuel dump port and vent clear.
65. Tip pod fin attachment.
66. Position light condition.



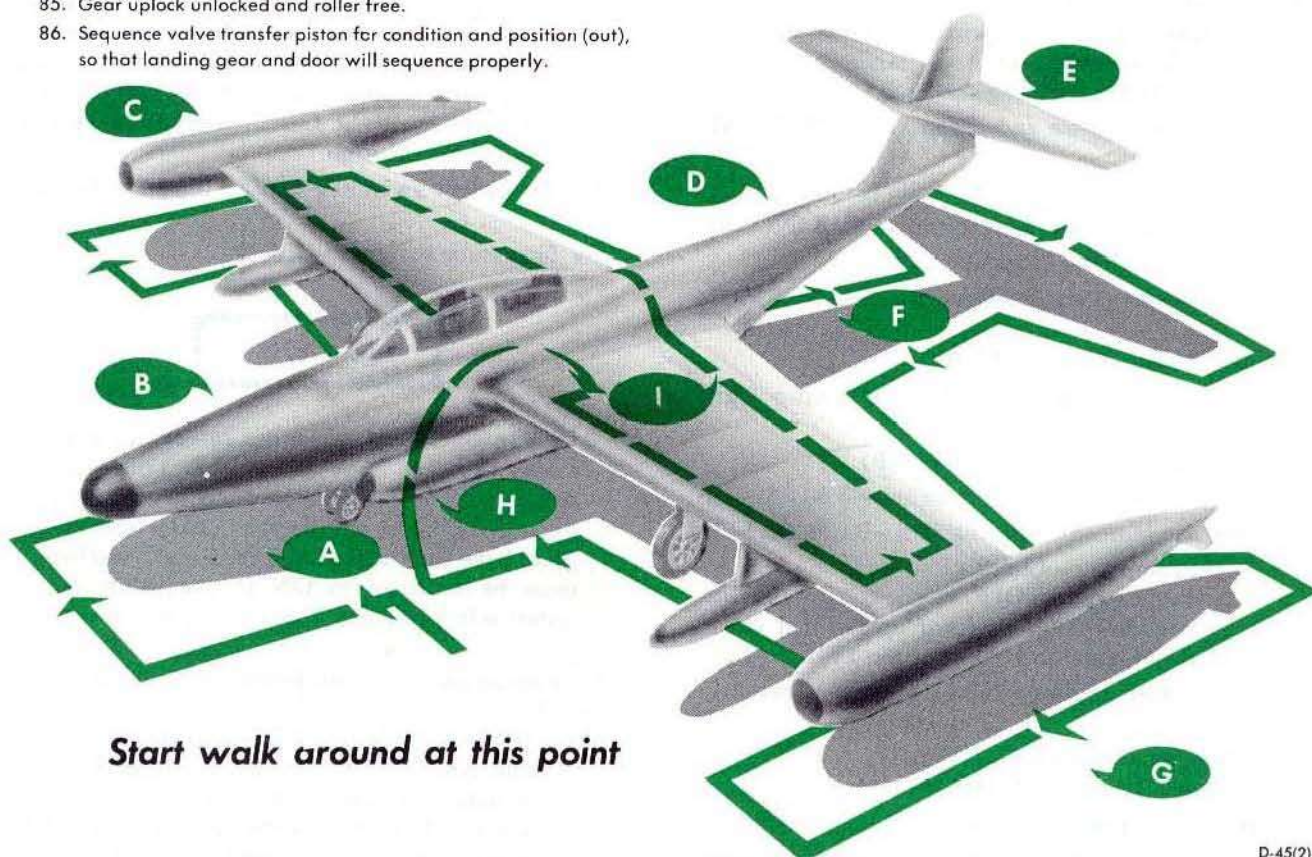
67. Tip tank access doors secured.
68. Anti-icing overboard duct clear.
69. Wing access doors secured.
70. Underside of wing for condition, fuel and hydraulic leaks, tiedown ring flush, and fuel vent outlets clear of obstructions.
71. Pylon tank pressure release valve closed.
72. Pylon tank filler cap secured.
73. Pylon vent port clear.
74. Pylon tank sway braces secured.
75. Pylon and tank for condition and leaks.
76. Wing leading edge condition.
77. Wheel chocks in place; ground lock removed.
78. Tire condition, inflation, and slippage.
79. Brake disc for condition, pucks for proper clearance, and brake shuttle valve checked.
80. Jack lug pointing straight downward.
81. Landing gear outboard door condition; strut extension (approximately six inches between torque arm pivot points), and check outboard door locking arm for tension.
82. Wheel well lines for condition and leaks.
83. Inboard main gear door closed and locked.
84. Bungee air pressure.
85. Gear uplock unlocked and roller free.
86. Sequence valve transfer piston for condition and position (out), so that landing gear and door will sequence properly.

LEFT SIDE

87. Eleventh-stage compressor bleed port clear.
88. Engine door No. 3 air scoop clear; inside door No. 3 air scoop, check for chafed fuel line. Engine door No. 4 air scoop clear (later airplanes).
89. Check oil quantity; oil filler cap secured.
90. Engine air intake doors free.
91. Engine doors secured.
92. Engine intake duct clear; screens and compressor blades aligned and undamaged. Check ground for foreign objects.
93. Evidence of fuel, oil, and hydraulic leaks.

I UPPER WING AND FUSELAGE

94. General condition of surface.
95. All fuel caps secured.
96. Tip tank pressure release valves flush and caps secured.
97. Static source outlets and cooling scoops on top of fuselage clear.
98. Fuselage light condition.
99. Emergency flap reservoir filler cap secured (left wing).
100. Alcohol tank cap secured (right wing).
101. Canopy seal and windshield condition.
102. Windshield wiper condition.
103. Radar access doors secured.
104. Canopy control door secured and emergency release handle stowed.



D-45(2)

17. Emergency flight control switch—OFF, or nose wheel steering button—Release. (P)
18. Supplemental pump pressure switch (some airplanes)—Check. (P)
Pump wheel brakes through several cycles to drop brake accumulator pressure to 1100-800 psi. Supplemental pump should come on and accumulator pressure should rise to approximately 2100 to 2350 psi.
19. Emergency flap system (Groups 1 through 35 airplanes)—Check. (P)
Emergency flap switch—ON, check flap operation and indicator light; emergency flap switch—OFF.
20. Pylon stores jettison switch—OFF. (P)
21. Throttles—CLOSED. (P)
22. Position light switches—As required. (P)
23. Landing gear warning horn reset button—Press. (P)
Landing gear lever light should come on.
24. Cabin temperature switch—AUTO. (P)
25. Cabin temperature rheostat—As required. (P)
26. Speed brake lever—CLOSED. (P)
27. Landing gear lever—Check DOWN. (P)
Check gear position indicator for safe indication. Emergency landing gear handle—Check IN (stowed position). (P)
28. Canopy seal button—Released. (P)
29. Landing and taxi light switches—As required. (P)
Check operation of both landing and taxi lights after extending the light.
30. Windshield de-ice and defog knob—NORMAL. (P)
31. Windshield wiper switch—OFF. (P)
32. Windshield wiper speed rheostat—Full INC. (P)
33. Anti-ice switch—As required. (P)
34. Screen emergency extension switch—NORMAL. (P)
35. Pitot heat switch—OFF. (P)
36. Canopy locking lever—UP. (Warning light on). (P)
37. Cabin air switch—PRESSURE. (P)
38. Cabin differential pressure switch—5.00 PSI. (P)
39. Attitude indicator warning flag—Retracted. (P)
40. Flight computer—Check. (P)
Altitude switch—OFF. Flight computer selector switch—OFF. Perform operational check of flight computer (See Section IV).
41. Directional indicator slaving cutout switch—IN. (P)
42. Altimeter and clock—Set. (P)
43. Armament switches—OFF. (P)
44. Parking brakes—Set. (P)
45. Emergency rudder trim knob (Groups 1 through 45 airplanes)—Centered. (P)
46. Canopy defog knob—In. (P)
47. Fire detector test switch (Groups 1 through 65 airplanes)—Check. (P)
Hold at CIRCUIT #1 and at CIRCUIT #2; warning lights should come on in less than 10 seconds.
48. Fire detector test switch—Check operation. (P)
(Group 70 and subsequent airplanes.) Hold to L & R FIRE CKT 1 and L OVERHEAT, left and right fire warning lights and left overheat warning light should come on within 2 to 10 seconds; hold to L & R FIRE CKT 2 and R OVERHEAT, left and right fire warning lights and right overheat warning light should come on.
49. Overheat detector test switch—Check operation. (P)
(Groups 1 through 65 airplanes.) Hold at LH ENG and at RH ENG; warning light should come on within 2 seconds.
50. Starting power switch—NORMAL (OFF). (P)
For emergency start—EMER (ON).
51. Canopy jettison "T" handle—In (stowed position). (P)
52. Thunderstorm light rheostat—OFF. (P)
53. Interior lighting rheostats—As required. (P—RO)
54. Oxygen equipment—Check operation. (P—RO)
Oxygen pressure gage—400 to 450 psi; oxygen warning light switch—OFF; oxygen regulator diluter lever—NORMAL OXYGEN; oxygen regulator supply lever—ON. (Refer to Oxygen System Preflight Check, Section IV, for detailed information.)
55. Autopilot switches—OFF; turn knob—Centered. (P)
56. Generator switches—ON. (P)

CAUTION

During emergency starts the 28-volt d-c generator switches must be at OFF. This is to prevent the left generator from overloading during the right engine start. After the engines have been started, the generator switches must be returned to ON in the following order: left, right No. 2, and right No. 1.

57. Communication equipment—Check operation. (P—RO)

(Canopy must be closed to check the ARN-6 and ARN-14.) Radio compass—Check all positions and tune to desired frequency; UHF command radio—Check all channels; VHF navigation set—Check and tune to desired frequency; interphone—Check operation.

58. IFF switch—STBY. (P)

Note

Leave IFF switch at OFF until alternator bus is energized. This will prevent the IFF circuit breaker from popping.

59. Right console circuit breakers—IN. (P)

60. Right vertical panel circuit breakers—IN. (P)

61. All press-to-test lights—Check operation. (P—RO)

62. All circuit breakers—Check In before starting engines. (P)

63. Flashlight—Check operation. (P)

64. Make sure that all required navigation publications are aboard. (P—RO)

STARTING ENGINES.

Whenever possible, start and run up engines on a concrete surface to prevent dirt and foreign objects from entering the compressors and damaging the engines. Avoid runup on macadam pavement; high exhaust gas temperatures may cause serious damage to the pavement aft of the airplane.

CAUTION

To reduce foreign object damage to the engines, external engine and side door air-inlet screens will be installed for taxiing to or from takeoff and landing areas and during ground operations. The engines should be at idle rpm or stopped during installation or removal of screens as a safeguard to ground crews. Personnel installing or removing the screens must approach from a 90-degree angle and to the rear of the inlet duct opening. One man must stand at the wing tip of the airplane to signal the pilot or operator in case of accident.

WARNING

Before starting engines, make sure danger areas (figure 2-3) fore and aft of the engines are clear of personnel, airplanes, and vehicles. Suction at the intake ducts is sufficient to kill or seriously injure personnel if pulled against or drawn into the ducts. Danger aft of the engines is created by the high exhaust gas temperature and blast from the tailpipes.

If the airplane is to be operated under conditions of possible carbon monoxide contamination, such as run-up or taxiing directly behind another jet airplane, or during runup with the tail into the wind, the following procedure must be used.

1. Before starting engines, both crewmembers don oxygen masks, connect tubes to oxygen regulator, and place diluter lever at 100% OXYGEN. (P—RO)

2. After contamination is no longer suspected, place the diluter lever at NORMAL OXYGEN. (P—RO)

WARNING

The oxygen diluter lever must be returned to NORMAL OXYGEN as soon as possible. Use of 100 percent oxygen could deplete the supply before the end of the mission.

CAUTION

Starting an engine by using the blast produced by another airplane or engine is prohibited. This method of starting engines forces foreign objects into the intake of the engine compressor section and results in engine failure.

Start the left engine first, to supply hydraulic pressure to the brake accumulator. See Section V for normal operating limits on recommended fuel or alternate fuel.

LEFT ENGINE.

1. Fire guard posted. (P)
2. Throttles—CLOSED. (P)
3. Fuel selector switches—ALL TANKS. (P)

WARNING

Group 75 airplanes in compliance with T.O. 1F-89-611 are modified to interlock the starter control circuit with the fuel selector switches, making it impossible to start an engine with the fuel selector in the PUMPS OFF position. This modification prevents loss of afterburner power during takeoff; however, this modification will have no effect on loss of afterburner power due to system malfunction or PUMPS OFF fuel selector switch settings made after starting engines.

- 4. Wing tank switches—ON; tip tank switches—ON; pylon tank switches—ON if pylon fuel is carried (Groups 1 through 70 airplanes). (P)
- 5. Crossfeed switch—OFF. (P)
- 6. Starter switch—START momentarily. (P)
Check for rise in oil pressure. If there is no indication of oil pressure immediately after

- starting, shut down engine and investigate.
- 7. Throttle—IDLE when engine reaches 7.5% rpm. (P)

The starter should automatically disconnect when the load drawn by the starter drops to 200 amperes (approximately 26% rpm for -47 engines and approximately 20% for -35 engines). If ignition does not occur within 5

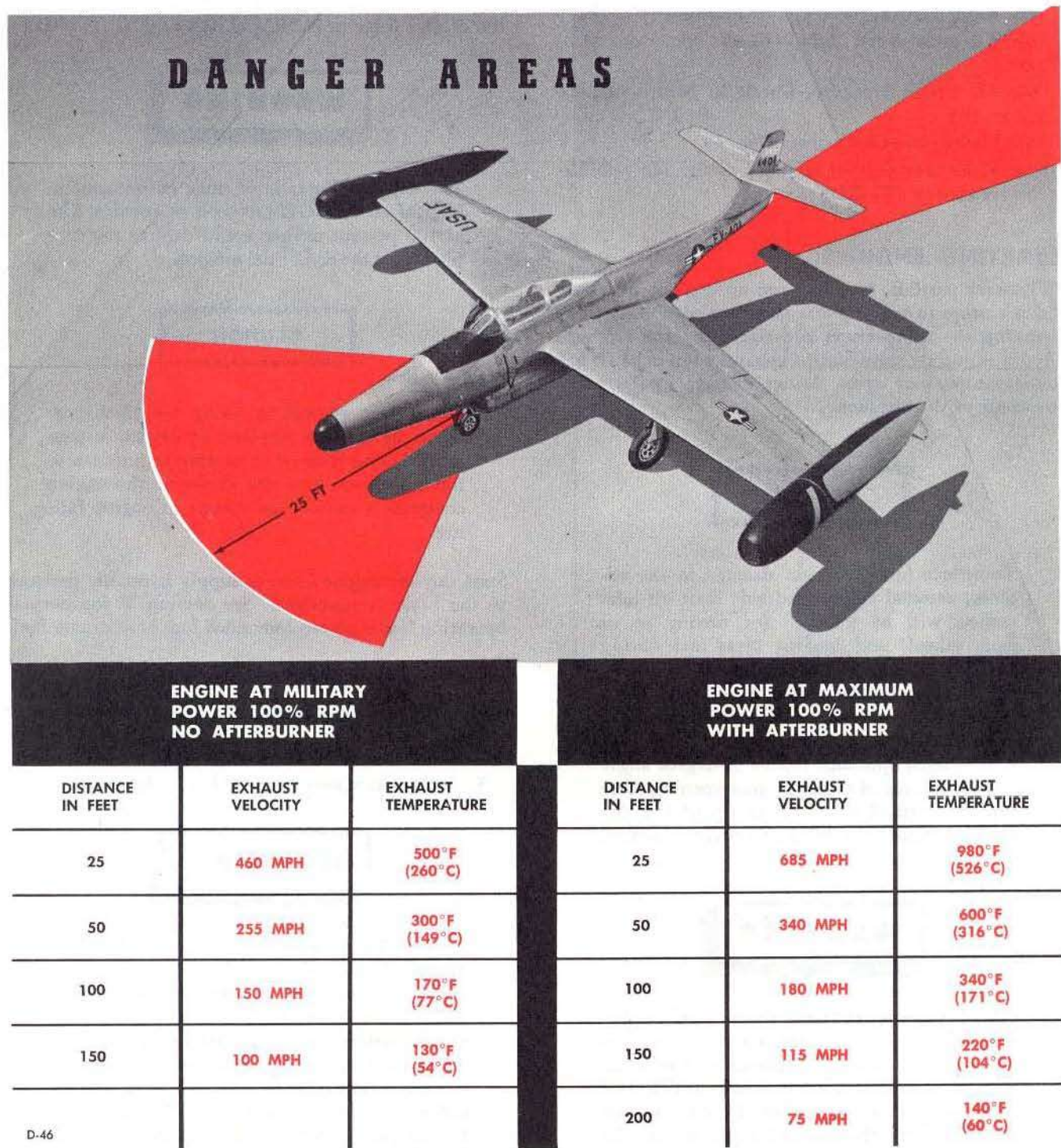


Figure 2-3.

seconds after moving throttle to IDLE, close throttle and place starter switch momentarily at STOP. Before attempting another start, wait 3 minutes to allow fuel to drain from the combustion chambers to minimize fire hazard.

CAUTION

The starter is limited to three starts of 1-minute duration each; if more than three starts are required, allow starter to cool for 30 minutes before using again.

8. Exhaust gas temperature and rpm—Stabilized at idle after ignition. (P)

9. Left flight control hydraulic pressure gage—Check while starting the left engine. (P)

When engine rpm is below 19%, the pressure should not exceed 400 psi; when engine rpm is above 38%, the pressure should be between 2800 and 3050 psi.

CAUTION

A hot start is a start during which the exhaust gas temperature exceeds 900°C on -47 engines, or 910°C on -35 engines. After any hot start during which the temperature reaches 1000°C, or five hot starts during which the temperature is less than 1000°C, a "hot section" inspection of the engine must be accomplished. Exhaust gas temperatures between 735°C and 900°C on -47 engines, and between 750°C and 910°C on -35 engines are permissible for no more than 20 seconds. All hot starts must be entered in DD Form 781.

WARNING

Some airplanes have J35-47 inner combustion liners installed on J35-35 engines. The cockpits of all airplanes so modified will be placarded, and the lower J35-47 engine operating temperature limits must be observed.

RIGHT ENGINE.

10. Right engine—Start as above. (P)
11. External power—Disconnected. (P)
12. Battery switch—ON. (P)
13. Fuel pump warning lights—OFF. (P)

14. Engine instruments—Check for desired readings at idle rpm. (P)

ENGINE GROUND OPERATION.

No warmup period is necessary.

CAUTION

- During starting and accelerations, the maximum allowable exhaust gas temperatures are 900°C on -47 engines, and 910°C on -35 engines. Exhaust gas temperatures between 735°C and 900°C on -47 engines, and between 750°C and 910°C on -35 engines are permissible for no more than 20 seconds.
- Do not exceed maximum rpm. If engine rpm exceeds 104% momentarily or 103% stabilized, with or without excessive exhaust gas temperature, the engine must be removed for overhaul. All overspeeding must be recorded in DD Form 781. See Section V for complete discussion on engine limitations.

GROUND TESTS.

Hold control stick back during ground tests.

VOLTAGE CHECK.

1. 28-volt generators—Check. (P)
With engines above 50% rpm, output of each 28-volt generator should be 27.5 volts; loadmeters should show 0.2 maximum permissible difference.
2. Alternator—Check. (RO)
With the left engine above 60% rpm, check the output of the 115/200-volt alternator.
3. Both single-phase inverter buses and three-phase inverter bus—Check output. (RO)
All three buses should read 115 volts with voltmeter selector switch at PWR INV PRI, PWR INV SEC, INST INV.
4. Three-phase inverter switch—SPARE (EMER). (P)
5. Three-phase inverter bus—Check output. (RO)
With voltmeter selector switch at INST INV, voltmeter should read 115 volts.
6. Three-phase inverter switch—MAIN (NORMAL). (P)
7. IFE switch—STDBY. (P)

HYDRAULIC SYSTEM CHECK.

To check the left and right hydraulic flight control systems individually, the left system must be checked before starting the right engine.

1. Speed brakes—Check operation. (P)

Flight control surfaces—Check operation. (P)

2. Flight control surfaces—Check operation. (P)
With both engines operating at idle rpm, operate all flight control surfaces simultaneously at maximum rate. The right flight control hydraulic pressure should not drop below 2500 psi.

AUTOPILOT CHECK (GROUP 35 AND SUBSEQUENT AIRPLANES).

Perform the following autopilot check. To save time and fuel, accomplish check while taxiing.

1. Autopilot power and autotrim switches—ON. (P)
Leave these switches on for the duration of the flight.
2. Turn knob—Check knob in detent position. (P)
3. Engaging switch—ENGAGE (after 1 1/2- to 2-minute warmup). (P)
The switch should remain at ENGAGE, and the manual controls should resist movement.
4. Turn knob—Rotate clockwise and counterclockwise. (P)
The stick should follow to the right and left as the knob is turned. Return the knob to the detent position.
5. Pitch knob—Rotate fore and aft. (P)
The stick should follow fore and aft. Return knob to detent position.
6. Yaw the airplane to the right, then to the left, with brakes. (P)
Left rudder pedal should move forward slightly when airplane is yawed to the right; right rudder pedal should move forward slightly when airplane is yawed to the left.
7. Operate the stick and rudder pedals manually. (P)
Forces required to overpower the autopilot should not be excessive.
8. Autopilot emergency disconnect switch (on control stick)—Squeeze. (P)
The engaging switch should return to the disengage position and the controls should be free.

Note

On those airplanes equipped with aileron travel limiters, perform the following additional checks.

9. Autopilot engaging switch—ENGAGE. (P)
10. Aileron travel limiter switch—ON. (P)
11. Turn knob—Rotate right or left until aileron travel reaches approximately 5 degrees. (P)
Engaging switch should snap to OFF and automatic disengagement indicator light should come on.
12. Autopilot emergency disconnect switch—Squeeze. (P)
The disengagement indicator light should go out. Turn knob—Return knob to the detent position. All controls should be free.

13. Aileron travel limiter switch—OFF, unless autopilot will be used with pylon tank fuel or tip tank fuel aboard. (P)

TAXIING INSTRUCTIONS.

Maintain directional control with steerable nose wheel. On airplanes not equipped with nose wheel steering, steer with the brakes.

CAUTION

To reduce foreign object damage to the engines, external engine and side door air-inlet screens will be installed for taxiing to or from takeoff and landing areas and during ground operations. The engines should be at idle rpm or stopped during installation or removal of screens as a safeguard to ground crews.

1. Ejection seat, canopy safety pins, and, on Group 5 airplanes, canopy jettison "T" handle guard—Removed. (P—RO)
2. Brake accumulator pressure—Check. (P)
3. Wheel chocks—Signal ground crew to remove. (P)
4. Parking brakes—Release. (P)
5. Flight indicators—Check during taxiing. (P)
6. Autopilot—Perform check. (P)

CAUTION

- Use of both wheel brake and nose wheel steering in turns will result in excessive stress on the nose gear and excessive nose wheel tire wear.
- Nose wheel tires will be severely damaged if maximum deflection turns are attempted at rolling speeds in excess of 10 knots.
- On airplanes not equipped with a supplemental hydraulic pump, use of the wing flaps and speed brakes simultaneously will result in inadequate brake pressure and an increase in nose wheel response time, necessitating greater rudder pedal throw than normal. Simultaneous use of wing flaps and speed brakes and maximum misuse of flight controls will result in inadequate brake pressure and complete loss of nose wheel steering.

Use 70% to 75% rpm to start the airplane rolling from a standing position, and 50% to 55% rpm to keep it

rolling. If taxiing with left engine only, a higher rpm is necessary. Maintain 60% to 70% rpm through turns at low speeds. This requires a large clear area aft of the tailpipes. A minimum of 115 feet of clear space ahead of the airplane is required to make a turn safely, starting from standstill. Minimize taxi time; flight range is considerably decreased by high fuel consumption during taxiing. In addition, airplane tires are not designed to withstand extended durations of ground rolling operations. Long taxi periods will build up excessive temperatures and pressures in the tires, resulting in decreased margin of safety and service life of tires. Estimated fuel consumption for taxiing with two engines operating is 30 to 70 pounds per minute; therefore, 1 minute of taxi time costs from 3 to 8 nautical miles at long range cruising speed.

BEFORE TAKEOFF.

PREFLIGHT AIRPLANE CHECK.

WARNING

Have external engine screens removed. Obtain clearance from ground crew that screens have been removed. The engines must be at idle rpm as a safeguard for the ground crew.

After taxiing to takeoff position, complete the following checks:

1. Canopy closed and locked, and warning light—Out. (P)
2. Flight controls—Check for free and correct movement. (P)
3. Elevator trim—Check for TAKE-OFF setting. (P)

WARNING

Be certain that airplane is trimmed properly for takeoff. Excessive trim may cause dangerous porpoising and possible stall.

4. Fuel selector switches—ALL TANKS. (P)

WARNING

If the fuel selector switches are placed at NOSE TANK or WING TANKS, afterburners, if ignited, may flame out. In addition, if a takeoff is attempted on a NOSE TANK selection, the aft cg limits of the airplane may be exceeded by expending nose tank fuel with full tip and sump tanks.

5. Safety belt—Tighten. Shoulder harness—Adjust to fit snugly; inertia reel lock lever—UNLOCK. (P—RO)
6. Anti "G" suit valve button—Depress to check operation. (P—RO)
7. Pitot heat switch—ON if necessary. (P)
(Check for increase on loadmeter.)
8. Wing flap lever—TAKE-OFF. (P)
9. Speed brake lever—CLOSED. (P)
10. Attitude indicator—Set. (P)
11. Hydraulic flight control, brake accumulator, and hydraulic reservoir pressure gauges—Check. (P)
12. Autopilot power and autotrim switches—ON. (P)
13. Check radar observer prepared for takeoff. (P)
14. Engine screens—Extended (if any foreign objects are apt to enter engine intake ducts). (P)

PREFLIGHT ENGINE CHECK.

Roll into takeoff position, center nose wheel, hold brakes, and perform the following checks:

1. Throttles—Full OPEN. (P)
Allow engine rpm to stabilize.
Observe exhaust gas temperatures and check instruments for desired ranges.

Note

Acceleration from idle to 100% rpm takes about 12 seconds.

CAUTION

Stabilized engine speeds greater than 103% rpm are prohibited and engine must be removed for overhaul if this rpm is exceeded. The throttle must be reset if stabilized engine speed exceeds 102% rpm.

2. Fuel gage selector switch—Check. (P)
With engines at military power, check at SUMP (MAIN). Low sump or main fuel level will indicate pylon tank or tip tank not feeding. On Groups 1 and 5 airplanes, failure of the pylon or tip tanks to feed will be further evidenced by the fuel transfer warning lights coming on.
3. Left afterburner—ON. (P)
Ignition will be indicated by thrust surge.
4. Right afterburner—ON. (P)
Ignite right afterburner as soon as exhaust gas temperature and rpm stabilize after lighting left afterburner.
5. Crossfeed switch—ON (Groups 1 through 70 airplanes) after both engines have accelerated to 100%.

rpm and both afterburners are functioning satisfactorily. (P)

Note

Stabilization of rpm and exhaust gas temperature takes approximately 3 to 4 seconds after initiation of afterburning. The rise in exhaust gas temperature and drop in rpm indicate proper afterburner ignition. The subsequent rise of rpm to normal indicates the opening of the eyelids. Stabilization of exhaust gas temperature is the final indication of eyelid opening, afterburning, and airworthiness of the engine.

CAUTION

- If eyelids do not open, as indicated by excessive exhaust gas temperature and drop in rpm, shut down afterburner, retard throttles, and taxi back to line.
- Except in cases of emergency, the engines should never be shut down immediately after afterburner shutdown. This practice tends to permit accumulation of raw fuel in the afterburner, which may reignite upon contact with hot engine parts. For normal operation it is recommended that the engine be operated for at least 5 minutes after shutting down the afterburner. This procedure will eliminate shroud ring seizure, overheated bearings, and the possibility of raw fuel accumulating in the afterburners and igniting from hot engines.

TAKEOFF.

NORMAL TAKEOFF.

Note

The procedure given below will produce the results stated in the Takeoff Distance Chart, figure A-5, in Appendix I.

When engines and afterburners are stabilized at 100% rpm, proceed with takeoff as shown in figure 2-4. See figure A-7 for maximum refusal speed, and at check-point (figure 2-4) note airspeed.

WARNING

Adhere closely to the nose wheel liftoff airspeeds to assure adequate lateral control and acceleration for takeoff.

Note

- Takeoff with military power is possible, but more distance is required. (See Takeoff Distance Chart, figure A-5 for military power takeoff distance.)
- The high rate of fuel consumption during takeoff and initial climb with afterburning will cause a slight drop in sump tank fuel level. This will be indicated by the fuel transfer warning lights blinking on Groups 1 and 5 airplanes. This is a normal condition and should be disregarded by the pilot if the transfer warning lights did not come on during check of tip tank or pylon tank feeding made before takeoff. (See Preflight Engine Check, this section.)

MINIMUM RUN TAKEOFF.

Strict adherence to takeoff procedure will result in minimum takeoff ground run. For length of ground run for various gross weights, see Takeoff Distance Chart (figure A-5).

OBSTACLE CLEARANCE TAKEOFF.

Follow normal takeoff procedure, using maximum power. After attaining the 50-foot height IAS (see After Takeoff—Climb, this section), maintain this IAS until obstacles are cleared, then continue with normal climb procedure.

CROSSWIND TAKEOFF.

Follow normal takeoff procedure with the following exceptions:

1. Use ailerons cautiously to maintain a wings-level attitude. (P)
2. Lift off at higher speeds than normal, depending on wind velocity. (P)
3. Hold nose wheel on runway until reaching takeoff speed. This will greatly reduce wheel braking. (P)

CAUTION

Crosswind takeoff ground run distance can be much greater than distances shown in the Takeoff Distance Charts, depending upon wind velocity.

Note

Use of nose wheel steering will greatly facilitate directional control during crosswind takeoff, and will minimize use of brakes.

AFTER TAKEOFF—CLIMB.

1. After takeoff, maintain approximate takeoff attitude to clear a 50-foot height at the following applicable airspeed: (P)

6 AFTER TAKEOFF MAINTAIN APPROXIMATE TAKEOFF ATTITUDE TO CLEAR A 50-FOOT HEIGHT AT 129 TO 151 KNOTS IAS DEPENDING ON GROSS WEIGHT.

5 GRADUALLY EASE STICK BACK TO LIFT NOSE WHEEL ALLOWING AIRPLANE TO FLY ITSELF OFF AT THE FOLLOWING APPLICABLE AIRSPEED:

GROSS WT POUNDS	TAKEOFF IAS KNOTS
46,600	139
42,000	132
38,000	126
34,000	119

4 KEEP NOSE WHEEL ON GROUND UNTIL THE FOLLOWING APPLICABLE AIRSPEED IS ATTAINED:

GROSS WT POUNDS	NOSE WHEEL LIFT-OFF—KNOTS
46,600	134
42,000	127
38,000	121
34,000	114

3 AT CHECKPOINT—
NOTE AIRSPEED

2 MAINTAIN DIRECTIONAL CONTROL WITH STEERABLE NOSE WHEEL (WITH MINIMUM USE OF BRAKES ON AIRPLANES NOT EQUIPPED WITH NOSE WHEEL STEERING) UNTIL RUDDER BECOMES EFFECTIVE AT ABOUT 70 KNOTS IAS.

1 RELEASE WHEEL BRAKES

TAKEOFF PROCEDURE

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Figure 2-4.

Gross Weight—Lb	IAS at 50 feet—Knots
46,700	151
42,000	144
38,000	137
34,000	129

WARNING

- It is important to adhere to the foregoing airspeed since stalling will be approached at a lower airspeed, and takeoff distance will be increased appreciably at higher airspeed.
- At takeoff airspeeds, aileron response may be somewhat less than at higher airspeeds. Takeoff airspeeds less than those recommended will aggravate this condition.

2. Landing gear lever—UP, when definitely airborne. (P)

Note

A priority valve in the hydraulic system gives priority to all flight controls over the landing gear system; therefore, if the landing flaps are retracted prior to a safe uplock landing gear indication, the gear movement will be delayed until the flaps are up.

CAUTION

Landing gear should be up and locked and the light in the control handle out before exceeding 195 knots IAS.

3. Wing flap lever—UP after attaining 160 knots IAS (170 knots IAS if full pylon tanks are carried). (P)

CAUTION

Wing flaps must be fully retracted before reaching structural limit airspeed to avoid possibility of structural damage.

Note

Flap operation is comparatively slow; therefore, flaps can be retracted in one complete lever movement from TAKEOFF to UP position. "Sink" effect is not critical with or without use of afterburners.

4. After reaching a safe altitude, increase airspeed to desired climbing speed. (P)

5. Emergency flight control switch—OFF after reaching 5000 feet above terrain on airplanes not equipped with supplemental pump. (P)

6. Check fuel gages. (P)

7. If 100 percent oxygen is used for takeoff because of suspected carbon monoxide contamination of cockpit, move diluter lever to NORMAL OXYGEN after contamination is no longer suspected. (P)

WARNING

The oxygen diluter lever must be returned to NORMAL OXYGEN as soon as possible. Use of 100 percent oxygen could deplete the supply before the end of the mission.

8. IFF switch—As required. (P)

9. Crossfeed switch—OFF upon reaching a safe altitude. (P)

Note

Because of the possibility of an unbalanced fuel load occurring if the crossfeed switch is left on, the pilot should make certain that the switch is placed at OFF as soon as a safe altitude is reached following takeoff.

To gain altitude efficiently, first accelerate to the best climb speed at constant altitude, then climb, maintaining the best climb airspeed according to the type of climb desired. If a climb is started before reaching the best climb airspeed, total time and fuel consumption will be increased. The best power for climb depends upon the performance required. Maximum power, military power, or normal power may be used. Optimum power settings for various performance requirements are described in the following paragraphs.

Note

The foregoing procedures will produce the results stated in the Climb Charts (figures A-9 and A-16) in Appendix I.

During climb, the following should be accomplished at 5000 feet, 10,000 feet, and at level-off altitudes:

10. Oxygen—Check. (P—RO)

11. Altimeter and cabin altitude—Check for proper operation. (P—RO)

12. Engine instruments—Check operation. (P)

13. Wings and fuselage—Check. (P)

MAXIMUM RATE OF CLIMB.

To climb at the maximum rate (minimum time climb), use maximum power and maintain airspeed schedule shown in Climb Charts (figures A-9 and A-16).

MINIMUM FUEL CLIMB.

To climb using minimum fuel without regard to distance gained, use military power at low altitudes and maximum power above 20,000 feet pressure altitude. Airspeeds shown in the Climb Charts (figures A-9 and A-16) are suitable for this type of climb.

MAXIMUM DISTANCE CLIMB.

To climb so that total distance covered, including cruise distance, is greatest for the fuel consumed, use military power and maintain the airspeed shown in the Climb Charts (figures A-9 and A-16).

MINIMUM DISTANCE CLIMB.

Minimum distance climb (maximum angle of climb) may be obtained at the following airspeeds depending upon gross weight and power:

<i>Gross Weight—LB</i>		<i>IAS—Knots</i>	
<i>Clean Configuration</i>	<i>Normal Power</i>	<i>Military Power</i>	<i>Maximum Power</i>
42,000	194	194	216
38,000	185	185	205
34,000	180	182	195

<i>Two 300-Gallon Pylon Tanks</i>	<i>Normal Power</i>	<i>Military Power</i>	<i>Maximum Power</i>
46,600	203	215	227
42,000	191	200	211
38,000	182	188	201
34,000	177	179	191

Note

- During locked throttle climb, engine rpm normally will not vary more than $\pm 2\%$.
- Minimum distance climb is not a maximum rate of climb.

CRUISE.

See Section VI and the Appendix for cruise characteristics of the airplane.

SYSTEMS OPERATION.

See Section VII for additional information on operation of the various systems.

DESCENT.

Any combination of power and speed brake position may be used during descent if the airspeed limitations in Section V are not exceeded.

1. Throttles and speed brakes—As required. (P)
2. Windshield defrosting system—As required. (P)
3. Canopy defogging system—As required. (P--RO)

Operate windshield defrosting system as required. Anticipate canopy fogging at low altitude and operate defogging system accordingly. Speed brakes can be opened at any airspeed.

4. Altimeter—Set and cross-checked with radar observer prior to descent. (P)

Note

If continuous radar operation is desired during a descent, do not retard the left throttle below the 48% rpm position on Groups 1 through 45 airplanes, as the alternator will be turned off.

A routine descent provides a compromise in fuel, time, and distance. This type of descent is normally used when a delay in landing clearance is anticipated. The descent is made at Mach 0.70 and idle power maintaining the airspeeds specified in the Descent Charts (figure A-23).

MINIMUM TIME DESCENT.

With speed brakes fully open and engines at idle rpm, descents up to 30,000 feet per minute can be made without exceeding 350 knots IAS.

BEFORE LANDING.

Before entering traffic pattern, airspeed may be varied within wide limits with speed brakes. It is recommended that the pattern be entered at about 270 knots IAS with speed brakes closed, using 85% rpm. If an airspeed lower than 270 knots IAS is desired, open speed brakes in preference to reducing power.

Note

- When power is stabilized at 85% rpm, approximately 4 seconds are required to obtain maximum power.
- Because engine compressors are designed for maximum efficiency at 100% rpm, compressor efficiency will drop as rpm is decreased to approximately 80% rpm. Therefore, if the engine is accelerated rapidly from 80% rpm to maximum power, a compressor stall may result. This is less likely to occur, however, at 85% or higher rpm since the compressor efficiency increases quite rapidly with an increase in rpm.

1. Alert radar observer. (P)
2. Safety belt and shoulder harness—Tightened; inertia reel lock lever—UNLOCK. (P--RO)
3. Armament switches—OFF. (P)
4. Wing and tip pod anti-ice systems—OFF; engine anti-icing system—As required. (P)

LANDING PATTERN

(Typical)

1

MAKE BEFORE-LANDING CHECK.

2

ENTER TRAFFIC PATTERN
AT 270 KNOTS IAS
USING 85% RPM.

6

TRIM — ADJUST AS
SPEED IS REDUCED.

7

CHECK INSTRUMENTS
FOR DESIRED RANGES.

8

TURN ONTO FINAL AT 170 KNOTS IAS.

9

FINAL APPROACH — WING FLAP LEVER — DOWN.

10

MAINTAIN 85% RPM UNTIL LANDING IS ASSURED.

WARNING:

AT HIGHER GROSS WEIGHTS, APPROACH AND TOUCHDOWN SPEEDS MUST BE INCREASED.
SEE LANDING SPEED CHARTS IN THE APPENDIX FOR OTHER WEIGHTS AND SPEEDS.

Figure 2-5.

(Based on a typical gross weight of 33,150 pounds)

AIRSPED — 195 KNOTS.
SPEED BRAKE LEVER — CLOSED.
LANDING GEAR LEVER — DOWN.
CHECK GEAR POSITION INDICATORS.
VISUALLY CHECK MAIN GEAR DOWN.

4

5

WING FLAP LEVER — TAKEOFF.

3

SPEED BRAKE LEVER — OPEN.

APPLY WHEEL BRAKES
INTERMITTENTLY TO
AVOID LOCKING WHEELS.

SET NOSE WHEEL DOWN
BEFORE REACHING
110 KNOTS IAS.

15

16

SPEED BRAKE LEVER — OPEN.

14

WITH TAIL SLIGHTLY DOWN, TOUCH
MAIN WHEELS DOWN AT 115 KNOTS IAS.

13

11

MAINTAIN DESIRED APPROACH
AT 143 KNOTS IAS.

12

WHEN LANDING IS ASSURED,
RETARD THROTTLES TO IDLE.

NOTE:

INCREASE APPROACH SPEED 2 KNOTS FOR EACH 1000 POUNDS
ABOVE THE WEIGHT CITED ON THE CHART.

WARNING

Use extreme caution when using wing anti-icing during landing because operation of the system causes a reduction in available thrust which must be considered if a go-around is necessary.

5. Windshield de-ice and defog knobs—As required. (P)
6. Emergency flight control switch—ON, on airplanes not equipped with left hydraulic system supplemental pump. (P)
7. Hydraulic pressure gages—Check. (P)
8. Brake accumulator pressure gage—Check. (P)
9. Crossfeed switch—ON, before entering traffic pattern. (P)
10. Engine screens—Extended (if any foreign objects are apt to enter engine intake ducts). (P)
11. Enter traffic pattern at 270 knots IAS using 85% rpm. (P)
12. Speed brake lever—OPEN. (P)
13. Landing gear lever—DOWN (195 knots maximum); check gear down. (P)
14. Speed brake lever—CLOSED. (P)
15. Wing flap lever—TAKE-OFF. (P)
16. Trim—Adjust as speed is reduced. (P)
17. Check instruments for desired ranges. (P)
18. Turn onto final at 170 knots IAS. (P)
19. Final approach—Wing flap lever—DOWN; airspeed—Check. (P)
20. Maintain 85% rpm until landing is assured. (P)
21. Maintain desired approach at 138 knots to 158 knots IAS, depending on gross weight. (P)

Gross Weight—Lb	Approach IAS—Knots
30,000	138
34,000	147
38,800	158

22. When landing is assured, retard throttle to IDLE. (P)

23. With tail slightly down, touch main wheels down at the following applicable airspeed. (P)

Gross Weight—Lb	Landing IAS—Knots
30,000	110
34,000	117
38,000	126

24. Speed brake lever—OPEN. (P)
25. Set nose wheel down at the following applicable airspeed. (P)

Gross Weight—Lb.

30,000

34,000

38,000

Nose Wheel Down

106

113

120

26. Apply wheel brakes intermittently to avoid locking wheels. (P)

Enter traffic pattern using 85% rpm and maintaining approximately 270 knots IAS, then proceed as shown in figure 2-5. See Section V for weight and cg limitations. Do not extend landing gear at airspeeds in excess of 195 knots IAS. After a normal landing or during a two engine go-around the gear retraction cycle must be complete (gear door up and locked) before the airplane exceeds 195 knots IAS. If practical the 195 knot IAS restriction should also be observed on single-engine go-around. In the event of simultaneous actuation of landing gear, flaps and speedbrakes, landing gear retraction time will be lengthened. After rapid descent from high altitude, allow for appreciably slower landing gear and wing flap extension rates caused by the low temperature of the hydraulic fluid. On airplanes not equipped with supplemental hydraulic pumps, landing gear extension will take longer than normal if the left engine rpm is below 85%, or if the wing flaps and speed brakes are operated simultaneously.

WARNING

- Speed brakes must be used with extreme caution while on final approach. If speed brake opening is increased rapidly, rapid deceleration may result in an excessive rate of descent or stalling while still airborne.

Note

At final approach and landing airspeeds, aileron response may be somewhat less than at higher airspeeds. Final approach and landing airspeeds less than those recommended will aggravate this condition.

Recommended final approach airspeeds are as follows:

Gross Weight—Lb.	Approach IAS—Knots
30,000	138
34,000	147
38,800	158

Note

The preceding speeds are approximately 5 knots above the stall speeds encountered under average gust conditions. Recommended final approach airspeeds for various gross weights are given in Appendix I.

For the landing procedure refer to figure 2-5. Aside from the somewhat high stick force encountered during flareout, the airplane is extremely easy to land. Tip and pylon tanks must be emptied before landing to prevent excessive loads in the tank attachment fittings. To avoid hard landings (touchdown at too high a rate of descent), do not open speed brakes fully until the airplane touches down. Increase in stalling speed plus rapid deceleration of the airplane may result in a stall while still airborne. If speed brakes are closed just before touchdown, decreased deceleration will result in a longer landing distance. The procedure just given will produce the results stated in the Landing Distance Chart (figure A-24) in Appendix I.

Note

- See Landing Speeds Chart (figure A-25) for landings at gross weights other than those given in this section.
- See Landing Distance Chart (figure A-24) for total landing distance from a 50-foot height using the normal landing procedure.

CROSSWIND LANDING.

Use normal landing procedure and correct for drift as necessary on approach and landing.

Note

Crabbing is considered the best technique for crosswind landings because of low aileron response below 150 knots IAS.

HEAVY WEIGHT LANDING.

Anticipate greater ground speed and rolling distance with increased gross weight, and begin braking at the applicable airspeeds listed in the Landing Distance Chart (figure A-24).

MINIMUM RUN LANDING.

For a minimum ground run, normal landing procedure is followed with one exception: the right engine is shut down immediately after three-wheel contact. The thrust eliminated by shutting down the idling right engine will aid in reducing the landing roll. Leave the wing flaps extended to take advantage of aerodynamic braking on the landing roll. Exercise care in brake application before the full weight of the airplane is on the wheels, to avoid skidding.

WET OR ICY RUNWAY LANDING.

Anticipate a 20 to 30 percent longer landing roll than normal because of decreased braking friction. Use the normal landing technique of full flaps with full speed brakes immediately following touchdown and shut down the right engine immediately after three-wheel contact. Depend upon flap and speed brake drag for initial deceleration, and apply wheel brakes cautiously

throughout the remainder of the landing roll to avoid skidding.

1. Leave the wing flaps fully extended until after turning off the runway.
2. Open the speed brakes after main gear touches down and leave extended until after turning off the runway.

GO-AROUND.

Because of slow engine and airplane acceleration, make decision to go around as soon as possible. If a landing cannot be completed, use the procedure shown on figure 2-6 as quickly as possible.

CAUTION

- If engines are being operated on nose tank only, with sump tanks empty (Groups 1 through 70 airplanes), or right main only, with left main tank empty (Group 75 airplanes), afterburning cannot be maintained on both engines; however, at the low gross weight associated with this fuel loading, military power is adequate for two-engine go-around.
- Landing gear should be up and locked and the light in the control handle out before exceeding 195 knots IAS.

AFTER LANDING.

After nose wheel is down, apply wheel brakes intermittently to avoid locking wheels. Only light brake pedal pressures are required because braking action is strong in comparison to the feel of the pedals. As weight on the wheels increases with reduction in speed, braking forces can be increased. Maximum braking occurs just before tires begin to skid. Because of the small tire tread and heavy weight of the airplane, the tires are easily skidded. See Section VII for added landing wheel brake information.

WARNING

Do not use nose wheel steering during landing roll. Engaging the steering system while the rudder pedals are deflected could result in an accident or structural damage by causing the airplane to swerve suddenly.

Airplanes equipped with the left hydraulic system supplemental pump can be taxied with the left engine inoperative, since the pump supplies hydraulic pressure

GO-AROUND

WARNING

BECAUSE OF SLOW ENGINE AND AIRPLANE ACCELERATION, MAKE DECISION TO GO AROUND AS SOON AS POSSIBLE. IF A LANDING CANNOT BE COMPLETED, DO THE FOLLOWING AS QUICKLY AS POSSIBLE:

THROTTLES—OPEN; AFTERBURNERS—ON (IF NECESSARY), AS SOON AS ENGINE SPEED PERMITS (AT OR ABOVE 90% RPM). **1**

NOTE

SPEED BRAKE LEVER—CLOSED. **2**

- LANDING GEAR RETRACTION DURING GO-AROUND IS SLOWER THAN NORMAL BECAUSE OF THE INCREASED DEMANDS ON THE HYDRAULIC SYSTEM BY SPEED BRAKE AND FLAP OPERATION. LANDING GEAR RETRACTION WILL BE FURTHER SLOWED IF ENGINE RPM DROPS BELOW 80%.

LANDING GEAR LEVER—UP, WHEN AIRPLANE IS DEFINITELY AIRBORNE. **3**

- ON AIRPLANES EQUIPPED WITH SUPPLEMENTAL PUMP, THE SPEED BRAKES, FLAP, AND LANDING GEAR OPERATION CAN BE SPEEDED UP BY DEPRESSING THE NOSE WHEEL STEERING BUTTON.

4 GRADUALLY RAISE WING FLAPS AS AIRSPEED INCREASES. SEE FIGURE 6-2 FOR APPLICABLE STALLING AIRSPEEDS.

5 CLEAR TRAFFIC AS SOON AS ADEQUATE AIRSPEED IS ATTAINED.

CAUTION

FUEL REQUIRED FOR GO-AROUND IS APPROXIMATELY 850 POUNDS WITH AFTERBURNING, AND APPROXIMATELY 625 POUNDS WITHOUT AFTERBURNING.



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Figure 2-6.

for steering and braking. Alternate use of the left and right engines for single-engine taxiing on these airplanes will tend to equalize taxi time on the two engines.

WARNING

If carbon monoxide contamination is anticipated during ground operation, oxygen should be used with the diluter lever at 100% OXYGEN.

CAUTION

- On airplanes *not* equipped with the supplemental hydraulic pump, do not taxi without the left engine operating as nose wheel steering and brake pressure will not be available.
- During the landing roll on airplanes not equipped with a left hydraulic system supplemental pump, do not operate the wing flaps and speed brakes simultaneously with the left engine at idle rpm. The demands on the hydraulic system may result in an excessively long time to recharge the brake accumulator and braking pressure may be depleted. If the normal hydraulic brake pressure is lost, release brake pedals, press down and turn the emergency airbrake handle to ON, and operate the brake pedals with CAUTION. (On Group 75 airplanes and some earlier modified airplanes it is not necessary to push down before turning.) The emergency airbrake system will supply enough pressure for three complete brake applications.
- Nose wheel tires will be severely damaged if maximum deflection turns are attempted at rolling speeds in excess of 10 knots.
- On airplanes not equipped with a left hydraulic system supplemental pump, use of the wing flaps and speed brakes simultaneously will result in an increase in nose wheel response time, and will necessitate greater rudder pedal throw than normal. Simultaneous use of wing flaps and speed brakes and maximum misuse of flight controls will result in complete loss of nose wheel steering. However, on airplanes equipped with a left hydraulic system supplemental pump, adequate hydraulic pressure in the left system will be maintained during final approach through actuation of the pump by the landing gear lever

switch. After touchdown, the pump will stop but will start again as brake accumulator pressure drops to 1100-800 psi when the airplane is decelerated.

1. Turn off of runway and come to a complete stop. (P)
2. Cabin air switch—RAM & DUMP. (Before opening canopy.) (P)
3. With engines at idle rpm, have external engine screens installed. (P)
4. Wing flap lever—UP. (P)
5. Emergency flight control switch—OFF, on airplanes equipped with emergency flight control pump. (P)
6. Speed brake lever—CLOSED. (P)
7. Trim—Reset to TAKE-OFF. (P)
8. Anti-icing, windshield de-ice, and pitot heat switch—OFF. (P)
9. Crossfeed switch—OFF. (P)
10. IFF—OFF. (P)
11. Taxi light—ON, if required. (P)
12. Seat armrest safety pins—Installed. (P—RO)

STOPPING ENGINES.

WARNING

To minimize the danger of explosion or fire due to fuel vapor, park the airplane into the wind when possible. Wait at least 15 minutes after engine operation (flight or ground) before going near the jet exhaust.

1. Parking brakes—Set. (P)
2. Canopy—Open. (P)
3. Flight controls—Neutral. (P)
4. Engines—Run up before shutdown. (P)

If engines have been operating at normal rated thrust or above (with or without afterburning) for 5 minutes or more, either in flight or on the ground, operate the engines at approximately 70% rpm for 5 minutes or more before shutting down, except in an emergency. During flight operation, approach and taxi time may be considered as part of this period.

Note

The preceding procedure will eliminate possible shroud ring seizure, overheated bearings, and the possibility of raw fuel accumulating in the afterburner and igniting from hot engine.

5. Throttles—Closed. (P)
Raise fingerlifts and move to CLOSED; throttle friction lever—INCREASE.
6. Fuel selector switches—OFF. (P)

Note

On Groups 1 through 70 airplanes, to prevent damaging the engine-driven fuel pump drive seal, the booster pump and fuel selector valve switches should not be turned off until the engine rotor has stopped turning.

7. All other switches—OFF, except generator switches. (P—RO)

BEFORE LEAVING AIRPLANE.

Surface control locks are not necessary because of the irreversible hydraulic control system.

1. Wheels chocked and brakes released. (P)
2. Insert ground safety pins in ejection seat and canopy jettison mechanism. (P—RO)
3. Oxygen tubes, radio cords, and personal equipment—Check properly stowed. (P—RO)

WARNING

When leaving airplane, make certain that no personal equipment which could become entangled with the seat armrests when the canopy is closed or opened, is left in the cockpit.

Otherwise, the canopy may be accidentally jettisoned with attendant personnel injury.

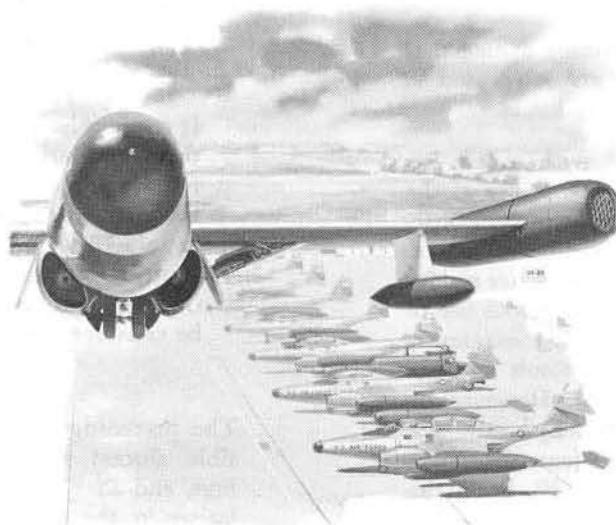
4. Complete DD Form 781.
5. Check pitot covers on; landing gear ground locks installed. (P)

CAUTION

- When leaving the airplane unattended, close and lock the canopy. This inflates the canopy seal, preventing moisture and dust from entering the cockpit. If the canopy is open on Groups 1 through 20 airplanes, it may blow off in a high wind or fall off when the airplane is being towed by the ground crew.
- If wearing an automatic-opening aneroid-type parachute that has a key attached to the aneroid arming lanyard, make sure key does not foul when leaving cockpit, to prevent chute from being opened inadvertently.

Note

The following pages contain a condensed checklist that has been prepared in a handy knee-pad size for your convenience. This checklist may be removed from the Flight Handbook and carried by you on all flights. Some detailed information normally found in the checklists has been purposely deleted for simplicity and ease of reading; however, all steps and pertinent details are included.



CONDENSED CHECKLIST

CUT ON DOTTED LINE

F-89D CONDENSED CHECKLIST**Note**

The following checklist is a condensed version of the airplane checklists. This checklist is accomplished by the radar observer calling off the items to the pilot. At the discretion of the pilot, the radar observer will assist in making the exterior inspection.

BEFORE EXTERIOR INSPECTION.

Check DD Form 781 for the status of the airplane; make sure that the airplane has been properly serviced.

EXTERIOR INSPECTION**Left Forward Side**

1. Pitot tube, static vents, and probe clear.
2. Hydraulic fluid and radome anti-icing fluid levels checked; caps secured.
3. Nose wheel tires for condition, inflation, and slippage.
4. Nose wheel door condition.
5. Nose wheel strut extension (approximately 3 inches); ground lock removed.
6. Static ground contact.
7. Fire extinguishing agent and bungee air pressures.
8. Landing-taxi lights condition.
9. Battery access door secured.
10. All access doors secured.
11. Radar nose condition, anti-icing nozzle clear.

Right Forward Side

12. All access doors secured; nose tank filler cap secured (some airplanes).
13. Hydraulic fluid level checked; cap secured.
14. Pitot tube and static vents clear.
15. Cabin pressure regulator outlet clear.
16. Engine intake duct clear, screens and compressor blades aligned and undamaged. Check ground for foreign objects.
17. Evidence of fuel, oil, and hydraulic leaks.
18. Engine doors secured.

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

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19. Engine air intake doors free.
 20. Check oil quantity; oil filler cap secured.
 21. Eleventh-stage compressor bleed port clear.
 22. Engine door No. 3 air scoop clear; inside door No. 3 air scoop, check for chafed fuel line. Engine door No. 4 air scoop clear (later airplanes).
- Right Wing**
23. Wheel chocks in place; ground lock removed.
 24. Tire condition, inflation and slippage.
 25. Brake disc for condition, pucks for proper clearance, and brake shuttle valve checked.
 26. Jack lug pointing straight downward.
 27. Landing gear outboard door condition. Strut extension (approximately six inches between torque arm pivot points), and check outboard door locking arm for tension.
 28. Wheel well lines for condition and leaks.
 29. Inboard main gear door closed and locked.
 30. Bungee air pressure.
 31. Sequence valve transfer piston for condition and position (out) so that landing gear and door will sequence properly.
 32. Gear uplock unlocked and roller free.
 33. Wing leading edge for condition.
 34. Underside of wing for condition, fuel leaks and hydraulic leaks; redown ring flush, and fuel tank vent outlets free of obstructions.
 35. Single-point refueling cap secured; refueling door locked.
 36. Pylon tank pressure release valve closed.
 37. Pylon tank filler cap secured.
 38. Pylon vent port clear.
 39. Pylon and tank for condition and leaks.
 40. Pylon tank sway braces secured.
 41. Wing access doors secured.
 42. Anti-icing overboard duct clear.
 43. Tip tank access doors secured.
 44. Position light condition.
 45. Tip pod fin attachment.
 46. Tip tank vent and fuel dump port clear.
 47. Aileron and wing flap for condition and hydraulic leaks, aileron neutral, wing flap up. Speed brake external ground lock removed.

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

Right Aft Fuselage

- 48. Tailpipe, fuel manifold, and flameholder condition.
- 49. Eyelids: closed, J35-47 engines; open, J35-35 engines.
- 50. Afterburner blastplate condition.
- 51. Refrigerator air intake and exhaust clear.
- 52. Aft fuselage access doors secured.
- 53. Fuselage position lights condition.

Empennage

- 54. General condition.
- 55. Drain ports for hydraulic leaks.
- 56. Position lights condition.
- 57. Access doors secured.
- 58. Rudder for approximate neutral position.

Left Aft Fuselage

- 59. Oxygen filler door secured.
- 60. Tailpipe, fuel manifold, and flameholder condition.
- 61. Eyelids: closed, J35-47 engines; open, J35-35 engines.
- 62. Afterburner blastplate condition.

Left Wing

- 63. Aileron and wing flap for condition and hydraulic leaks, aileron neutral, wing flap up. Speed brake external ground lock removed.
- 64. Tip tank fuel dump port and vent clear.
- 65. Tip pod fin attachment.
- 66. Position light condition.
- 67. Tip tank access doors secured.
- 68. Anti-icing overboard duct clear.
- 69. Wing access doors secured.
- 70. Underside of wing for condition, fuel and hydraulic leaks, tiedown ring flush, and fuel vent outlets clear of obstructions.
- 71. Pylon tank pressure release valve closed.
- 72. Pylon tank filler cap secured.
- 73. Pylon vent port clear.
- 74. Pylon tank sway braces secured.
- 75. Pylon and tank for condition and leaks.
- 76. Wing leading edge condition.
- 77. Wheel chocks in place; ground lock removed.

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

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104. Canopy control door secured and emergency release handle stowed.
103. Radar access doors secured.
102. Windshield wiper condition.
101. Canopy seal and windshield condition.
100. Alcohol tank cap secured (right wing).
99. Emergency flap reservoir filler cap secured (left wing).
98. Fuselage light condition.
97. Static source outlets and cooling scoops on top of fuselage clear.
96. Tip tank pressure release valves flush and caps secured.
95. All fuel caps secured.
94. General condition of surface.

Upper Wing and Fuselage

93. Evidence of fuel, oil, and hydraulic leaks.
undamaged. Check ground for foreign objects.
92. Engine intake duct clear, screens and compressor blades aligned and
91. Engine doors secured.
90. Engine air intake doors free.
89. Check oil quantity, oil filler cap secured.
planes).
for chafed fuel line. Engine door No. 4 air scoop clear (later air-
88. Engine door No. 3 air scoop clear; inside door No. 3 air scoop, check
87. Eleventh-stage compressor bleed port clear.

Left Side

86. Sequence valve transfer piston for condition and position (out), so
that landing gear and door will sequence properly.
85. Gear uplock unlocked and roller free.
84. Bungee air pressure.
83. Inboard main gear door closed and locked.
82. Wheel well lines for condition and leaks.
board door locking arm for tension.
81. Landing gear outboard door condition. Strut extension (approx-
imately 6 inches between torque arm pivot points), and check out-
80. Jack lug pointing straight downward.
and brake shuttle valve checked.
79. Brake disc for condition, pucks for proper clearance.
78. Tire condition, inflation, and shippage.

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

BEFORE ENTERING COCKPIT.

1. Ejection seats—Check. (P—RO)
2. Canopy ejector pressure—Check. (P—RO)
3. Armament safety control switch—SAFE—OFF. (P)

ON ENTERING COCKPIT.**INTERIOR CHECK**

1. Safety belt and shoulder harness—Fasten; inertia reel operation—Check; automatic-opening parachute lanyard—Connected. (P—RO)
2. Rudder pedals—Adjust. (P)
3. Battery switch—OFF. (P)
4. 28-volt d-c external power—Have connected. (P)
5. Instrument inverter switch (Groups 1 through 30 airplanes)—Check SPARE and MAIN—Leave on MAIN. (P)
6. Power inverter switch (Groups 1 through 30 airplanes)—Check SPARE and MAIN—Leave on MAIN. (P)
7. Three-phase inverter switch (Group 35 and subsequent airplanes)—Check SPARE and MAIN—Leave on MAIN. (P)
8. Single-phase inverter switch (Group 35 and subsequent airplanes)—Check EMERGENCY and NORMAL—Leave on NORMAL. (P)
RO check three voltages. (RO)
9. Left console circuit breakers—IN. (P)
10. Emergency airbrake valve handle—OFF. (P)
11. Sideslip stability augmenter switch—ON; rudder trim switch (Group 50 and subsequent airplanes)—AUTO TRIM. (P)
12. Single-point fueling light—OUT. (P)
13. Fuel control panel and fuel gages—Check. (P)
14. Emergency flight control switch—ON, or nose wheel steering button—Depress. (P)
15. Operate all flight controls simultaneously. (P)
16. Aileron and elevator trim switch—Check. (P)
17. Emergency flight control switch—OFF, or nose wheel steering button—Release. (P)
18. Supplemental pump pressure switch (some airplanes)—Check. (P)
19. Emergency flap system (some airplanes)—Check. (P)
20. Pylon stores jettison switch (some airplanes)—OFF. (P)
21. Throttles—CLOSED. (P)
22. Position light switches—As required. (P)
23. Landing gear warning horn reset button—Press. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

24. Cabin temperature switch—AUTO. (P)
 25. Cabin temperature rheostat—As required. (P)
 26. Speed brake lever—CLOSED. (P)
 27. Landing gear lever—Check DOWN. Emergency landing gear handle—Check IN (stowed position). (P)
 28. Canopy seal button—Released. (P)
 29. Taxi and landing light switches—As required. (P)
 30. Windshield de-ice and defog knob—NORMAL. (P)
 31. Windshield wiper switch—OFF. (P)
 32. Windshield wiper speed rheostat—Full INC. (P)
 33. Anti-ice switch—As required. (P)
 34. Screen emergency extension switch—NORMAL. (P)
 35. Pitot heat switch—OFF. (P)
 36. Canopy locking lever—UP. (P)
 37. Cabin air switch—PRESSURE. (P)
 38. Cabin differential pressure switch—5.00 PSL. (P)
 39. Attitude indicator warning flag—Retracted. (P)
 40. Flight computer—Check. Altitude switch—OFF. (P)
 41. Directional indicator slaving cutout switch—IN. (P)
 42. Altimeter and clock—Set. (P—RO)
 43. Armament switches—OFF. (P)
 44. Parking brakes—Set. (P)
 45. Emergency rudder trim knob (Groups 1 through 45 airplanes)—Centered. (P)
 46. Canopy defog knob—IN. (P)
 47. Fire detector test switch (Groups 1 through 65 airplanes)—Check. (P)
 48. Fire detector test switch (Group 70 and subsequent airplanes)—Check operation. (P)
 49. Overheat detector test switch (Groups 1 through 65 airplanes)—Check operation. (P)
 50. Starting power switch—NORMAL (OFF). For emergency start—EMER (ON). (P)
 51. Canopy jettison "T" handle—IN (stowed position). (P)
 52. Thunderstorm light rheostat—OFF. (P)
 53. Interior lighting rheostat—As required. (P)
 54. Oxygen pressure gage—400 to 450 psi. (P)
 55. Oxygen warning light switch—ON. (P)
 56. Oxygen regulator diluter lever—NORMAL OXYGEN; oxygen regulator supply lever—ON. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

57. Oxygen equipment—Check operation. (P)
58. Autopilot switches—OFF; turn knob—Centered. (P)
59. Generator switches—ON. (P)
60. Communication equipment—Check operation. (P—RO)
61. IFF switch—STBY. (P)
62. Right console circuit breakers—IN. (P)
63. Right vertical panel circuit breakers—IN. (P)
64. ALL press-to-test lights—Check operation. (P—RO)
65. ALL circuit breakers—Check IN before starting engines. (P—RO)
66. Flashlight—Check operation. (P—RO)
67. Make sure that all required navigation publications are aboard. (P—RO)

STARTING ENGINES.

1. Fire guard posted. (P)
2. Throttles—CLOSED. (P)
3. Fuel selector switches—ALL TANKS. (P)
4. Wing tank switches—ON; tip tank switches—ON; pylon tank switches—ON if pylon fuel is carried. (Groups 1 through 70 airplanes.) (P)
5. Crossfeed switch—OFF. (P)
6. Starter switch—START momentarily. (P)
7. Throttle—IDLE when engine reaches 7.5% rpm.
8. Exhaust gas temperature and rpm—Stabilized at idle after ignition. (P)
9. Hydraulic system pressure gage—Check while starting engine. (P)

RIGHT ENGINE.

10. Right engine—Start as above. (P)
11. External power—Disconnected. (P)
12. Battery switch—ON. (P)
13. Fuel pump warning lights—OFF. (P)
14. Engine instruments—Check for desired readings at idle rpm. (P)

GROUND TESTS.**Voltage Check.**

1. 28-volt generators—Check. (P)
2. Alternator—Check. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

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1. Ejection seat, canopy safety pins and, on Group 5 airplanes, canopy
2. Brake accumulator pressure—Check. (P)
3. Wheel chocks—Signal ground crew to remove. (P)
4. Parking brakes—Release. (P)
5. Flight indicators—Check during taxiing. (P)
6. Perform autopilot check. (P)

TAXIING INSTRUCTIONS.

1. Autopilot power and autopilot switches—ON. (P)
2. Turn knob—Check knob in detent position. (P)
3. Engaging switch—ENGAGE. (P)
4. Turn knob—Rotate clockwise and counterclockwise; pitch knob—Rotate fore and aft. (P)
5. With nose wheel steering disengaged, yaw the airplane to the right, then to the left with brakes. (P)
6. Operate the stick and rudder pedals manually to check forces required to overpower the autopilot. (P)
7. Autopilot emergency disconnect switch on control stick—Squeeze. (P)
8. Autopilot engaging switch—ENGAGE. (P)
9. Alleron travel limiter switch—ON. (P)
10. Turn knob—Check operation. (P)
11. Autopilot emergency disconnect switch—Squeeze. Turn knob—Return knob to the detent position. (P)
12. Alleron travel limiter switch—OFF, unless autopilot will be used with pylon tank fuel and/or tip tank fuel aboard. (P)

Autopilot Check (Group 35 and Subsequent Airplanes).

1. Speed brakes—Check operation. (P)
2. Flight control surfaces—Check operation. (P)

Hydraulic System Check.

3. Both single-phase inverter buses and three-phase inverter bus—Check output. (RO)
4. Three-phase inverter switch—SPARE. (P)
5. Three-phase inverter bus—Check output. (RO)
6. Three-phase inverter switch—MAIN. (P)
7. IFF switch—STDBY. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

BEFORE TAKEOFF.**Preflight Airplane Check.**

1. Canopy closed and locked and warning light—OUT. (P)
2. Flight controls—Check for free and correct movement. (P)
3. Elevator trim—Check for TAKE-OFF setting. (P)
4. Fuel selector switches—ALL TANKS. (P)
5. Safety belt—Tighten; safety belt ground safety pins—Removed; shoulder harness—Adjust to fit snugly; inertia reel lock lever—UNLOCK. (P—RO)
6. Anti "G" suit valve button—Depress to check operation. (P—RO)
7. Pitot heat switch—ON if necessary (check for increase on load-meter). (P)
8. Wing flap lever—TAKE-OFF. (P)
9. Speed brake lever—CLOSED. (P)
10. Attitude indicator—Set. (P)
11. Hydraulic flight control, brake accumulator, and hydraulic reservoir pressure gages—Check. (P)
12. Autopilot power and autotrim switches—ON. (P)
13. Check radar observer prepared for takeoff. (P)
14. Engine screens—Extended. (P)

Preflight Engine Check.

1. Nose wheel—Centered. (P)
2. Brakes—Hold. (P)
3. Throttles—Open. (P)
4. Exhaust gas temperatures—Check. (P)
5. Fuel gage selector switch—SUMP (MAIN). (P)
6. Fuel transfer warning light—Check. (P)
7. Left engine afterburner—Initiate. (P)
8. Right engine afterburner—Initiate. (P)
9. Engine rpm—Check. (P)
10. Exhaust gas temperatures—Check. (P)
11. Crossfeed switch—ON (Groups 1 through 70 airplanes). (P)

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CUT ON DOTTED LINE

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

BEFORE LANDING.

1. Alert radar observer. (P)
2. Safety belt and shoulder harness—Tightened; inertia reel lock lever—UNLOCK. (P—RO)
3. Armament switches—OFF. (P)
4. Wing and tip pod anti-ice systems—OFF. (P)
5. Windshield de-ice and defog knob—As required. (P)
6. Emergency flight control switch (on airplanes so equipped)—ON. (P)
7. Hydraulic pressure gages—Check. (P)
8. Brake accumulator pressure gage—Check. (P)
9. Crossfeed switch—ON. (P)
10. Engine screens—Extended. (P)
11. Enter traffic pattern at 270 knots IAS using 85% rpm. (P)
12. Speed brake lever—OPEN. (P)
13. Landing gear lever—DOWN (195 knots IAS); check gear down. (P)
14. Speed brake lever—CLOSED. (P)
15. Wing flap lever—TAKE-OFF. (P)
16. Trim—Adjust as speed is reduced. (P)
17. Check instruments for desired ranges. (P)
18. Turn onto final at 170 knots IAS. (P)
19. Final approach—Wing flap lever—DOWN. (P)
20. Maintain 85% rpm until landing is assured. (P)
21. Maintain desired approach at 138 knots to 158 knots IAS, depending upon gross weight. (P)

<i>Gross Weight — Lb</i>	<i>Approach IAS — Knots</i>
30,000	138
34,000	147
38,800	158

22. When landing is assured, retard throttle to—IDLE. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

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11. Seat armrest safety pins—Installed. (P—RO)

10. Taxi light—ON, if required. (P)

9. IFF—OFF. (P)

8. Crossfeed switch—OFF. (P)

7. Anti-icing, windshield de-ice, and pitot heat switch—OFF. (P)

6. Trim—Reset to TAKE-OFF. (P)

5. Speed brake lever—CLOSED. (P)

4. Emergency flight control switch—OFF (on airplanes so equipped). (P)

3. Wing flap lever—UP. (P)

2. External engine screens—Installed. (P)

1. Turn off of runway and stop. (P)

AFTER LANDING.

1. Throttles—OPEN (afterburners on if necessary). (P)

2. Speed brake lever—CLOSED. (P)

3. Landing gear lever—UP. (P)

4. Wing flaps—As required. (P)

GO-AROUND.

26. Apply wheel brakes intermittently to avoid locking wheels.

38,800

34,000

30,000

120

113

106

Gross Weight — Lb

Nose Wheel Down

25. Set nose wheel down at the following applicable airspeed. (P)

38,000

34,000

30,000

126

117

110

Gross Weight — Lb

Landing IAS — Knots

23. With tail slightly down, touch main wheels down at the following applicable airspeed. (P)

38,000

34,000

30,000

126

117

110

Gross Weight — Lb

Landing IAS — Knots

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

STOPPING ENGINES.

1. Parking brakes—Set. (P)
2. Canopy—OPEN. (P)
3. Flight controls—Neutral. (P)
4. Operate engines at approximately 70% rpm for 5 minutes before shutting down. (P)
5. Throttles—Raise fingerlifts and move to CLOSED; throttle friction lever—INCREASE. (P)
6. Fuel tank switches and selector switches—OFF. (P)
7. Turn all other switches to OFF except generator switches. (P—RO)

BEFORE LEAVING AIRPLANE.

1. Wheels chocked and brakes released. (P)
2. Insert ground safety pins in ejection seat and canopy jettison mechanism. (P—RO)
3. Check that the oxygen tubes and radio cords are properly stowed. (P—RO)
4. Complete DD Form 781. (P)
5. Check pitot covers on; landing gear ground locks installed. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

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Section III

EMERGENCY PROCEDURES

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Procedure steps in this section are followed by the symbols P, RO, or P—RO in parentheses to indicate whether the particular step is applicable to the pilot, radar observer, or both crewmembers.

ENGINE FAILURE.

SINGLE-ENGINE FLIGHT CHARACTERISTICS.

Single-engine directional flight control characteristics are essentially the same as normal flight characteristics

because of the proximity of the thrust lines to the centerline of the airplane. With one engine inoperative, very little rudder deflection is required. Thus, good control is assured in the single-engine range. Minimum single-engine control speed is airspeed at stall.

This airspeed varies with gross weight, wing flap setting, speed brake setting, and acceleration (such as that encountered in banks and pull-ups). An airspeed of 160 knots IAS (170 knots IAS if pylon tanks are full) is a safe minimum for all weights, all configurations, and moderate accelerations. See figure 3-2, for single-engine service ceilings. In single-engine flight where only military power (100% rpm without afterburning) is available on the operating engine, there are certain airplane configurations in which level flight cannot be maintained. At a typical takeoff gross weight of 42,000 pounds (pylon tanks empty or dropped), one engine windmilling, flaps open 30 degrees or more, and with the landing gear *up* or *down*, it is impossible to maintain level flight. With the flaps *up* and the landing gear *up* or *down*, level flight is possible; however, until the landing gear is retracted or afterburning initiated, performance will be marginal and any turns or maneuvers may be accompanied by a loss of altitude.

SINGLE-ENGINE PROCEDURE.

Immediately after experiencing engine failure in flight it is important to reduce drag to a minimum and yet maintain IAS and directional control while investigating for the cause of the engine failure. If the cause of the malfunction cannot be determined, or it is not safe to continue operation, the procedure given below should be followed for shutting down an engine in flight. This procedure can be used for simulating flameouts, engine failure resulting from mechanical failure, fuel system malfunction, icing conditions, and all other conditions of engine failure:

1. Both throttles—Full OPEN. (P)
2. Gear and flaps—Retract, if extended. (P)
3. Throttle (affected engine)—CLOSED. (P)
4. Engine fire selector switch on dead engine—Raise guard and actuate switch. (P)
5. Agent discharge switch—Actuate, if necessary. (P)

CAUTION

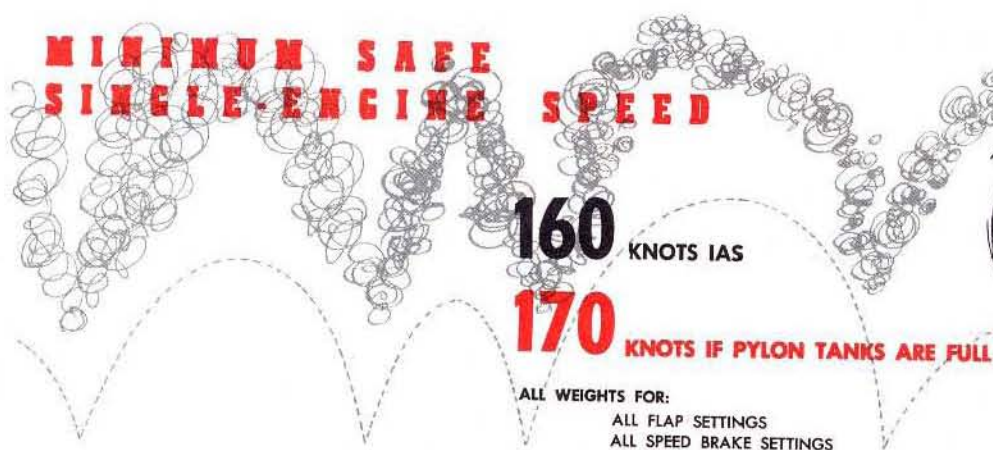
Do not actuate agent discharge switch unless engine is on fire.

6. Generator switch (affected engine)—OFF. (P)
7. Inverter switches—As required. (P)
8. Unnecessary electrical equipment—OFF. (P—RO)
9. Crossfeed switch (Groups 1 through 70 airplanes)—ON, (Group 75 airplanes)—OPEN. (P)
10. Fuel tank switches (Groups 1 through 70 airplanes)—ON, except on empty tanks. (P)
11. Fuel selector switches—ALL TANKS. (P)

CAUTION

- If right engine is inoperative, do not operate speed brakes unless left engine rpm is at least 85%. At lower rpm, the demand of speed brake operation on the hydraulic system causes limited aileron control.
- If left engine is out, on airplanes not equipped with left hydraulic system supplemental pump, speed brakes will be inoperative; landing gear may be lowered by the emergency procedure; and, on Groups 1 through 35 airplanes, flaps may be lowered by the emergency flap system.

12. Power on good engine—Readjust. (P)
13. Trim for straight and level flight. (P)



DF-13

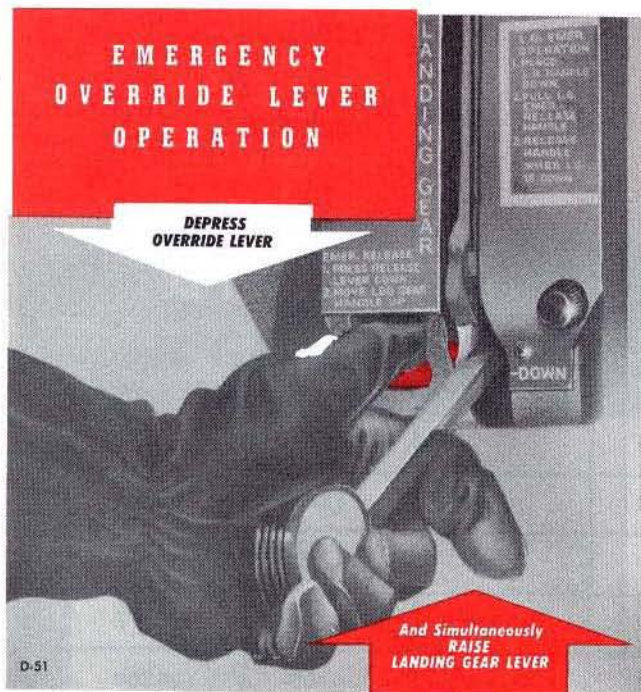


Figure 3-1.

ENGINE FAILURE DURING TAKEOFF (BEFORE LEAVING GROUND).

Takeoff Aborted.

If an engine fails before leaving the ground, continuing the takeoff depends on length of runway, configuration, gross weight, airspeed at time of failure, field elevation, and ambient temperature. To help the pilot make a decision, single-engine takeoff distances for various gross weights, altitudes, and ambient temperatures are shown in the Appendix, figure A-5. This chart gives entire takeoff distance with only one engine operating at maximum power, and is to be used only if an engine fails during the takeoff roll. If a decision to stop is made, use the following procedure:

1. Alert radar observer. (P)
2. Throttles (both engines)—CLOSED. (P)
3. Speed brake lever—OPEN. (P)
4. Wheel brakes—Apply (maximum braking occurs at a point just before tires skid). (P)
5. Emergency airbrake system—As required. Nose wheel steering button—Depress, on airplanes equipped with left hydraulic system supplemental pump. (P)

WARNING

- If hydraulic pressure is insufficient for adequate braking and the airplane is not equipped

with a supplemental hydraulic pump, use the emergency airbrake system.

- If the airplane is equipped with a left hydraulic system supplemental pump, depress the nose wheel steering button to start the pump if braking pressure is not maintained automatically. If hydraulic pressure is still insufficient for adequate braking, use the emergency airbrake system.
6. Canopy—Jettison with canopy jettison "T" handle. (P)
 7. Inertia reel—LOCK. (P—RO).

Note

All equipment should be set as required prior to locking inertia reel, as some smaller pilots may find it difficult to reach such items as the canopy jettison "T" handle after the inertia reel is locked.

8. Steer for smoothest terrain if remaining runway is insufficient for stopping. (P)

9. If necessary, raise landing gear by depressing the emergency override lever and simultaneously moving the landing gear lever to UP. (P)

WARNING

- On airplanes not modified in accordance with T.O. 1F-89-615 and 1F-89-520, place feet on instrument panel to avoid injury as nose gear strut may come through the floor of the pilot's compartment.
 - If the left engine has failed and the airplane is not equipped with a left hydraulic system supplemental pump, the landing gear may or may not retract, depending on available hydraulic pressure in the left system. However, if the airplane is equipped with a supplemental hydraulic pump in the left system, adequate hydraulic pressure may be maintained by energizing the supplemental pump with the nose wheel steering button.
10. Engine fire selector switches—Raise guards and actuate. (P)
 11. Agent discharge switch—Actuate. (P)
 12. Battery switch—OFF. (P)
 13. Generator switches—OFF. (P)
 14. When stopped—Abandon airplane. (P—RO)

SINGLE-ENGINE SERVICE CEILING



NOTE: ALL ALTITUDES ARE PRESSURE ALTITUDES IN FEET

GROSS WEIGHT POUNDS	ALTITUDE STD DAY 59°F (15°C) AT SL			ALTITUDE HOT DAY 100°F (38°C) AT SL		
	96% RPM WITHOUT AB	100% RPM WITHOUT AB	100% RPM WITH AB	96% RPM WITHOUT AB	100% RPM WITHOUT AB	100% RPM WITH AB
46,000	5600	8900	20,000		5100	17,300
42,000	8750	11,200	23,000		7800	20,500
38,000	12,200	14,050	26,300	*6000	10,700	23,850
34,000	16,000	17,300	30,200	*12,100	13,800	27,200
30,000	20,000	20,800	34,450	16,200	16,900	30,500

*WITH POWER REDUCED TO PREVENT EXCEEDING EXHAUST GAS TEMPERATURE LIMIT.

DATA AS OF: 15 MARCH 1956

DATA BASIS: FLIGHT TEST

D-50(1)

Figure 3-2.

ENGINE FAILURE DURING TAKEOFF (AFTER LEAVING GROUND).

If an engine fails immediately after takeoff, lateral and directional control of the airplane can be maintained if airspeed remains above stalling speed, but ability to maintain altitude or to climb depends upon gross weight, airplane configuration, and air density. Figure 3-3 shows, for clean configuration and pylon tank configuration, the maximum gross weights at which a 100-foot-per-minute rate of climb can be maintained with landing gear down and flaps at takeoff. For engine failure immediately after takeoff, use the following applicable procedure:

Takeoff Continued.

1. Warn radar observer of engine trouble. (P)
2. Landing gear lever—UP. (P)

Note

- If an immediate obstacle must be cleared, do not retract gear until obstacle is cleared. Retraction of the gear creates considerable additional drag. If the airplane is accelerating and no immediate obstacle must be cleared, the gear should be retracted.
- If left engine is inoperative, gear will not retract on airplanes not equipped with a

supplemental left hydraulic system pump, as the gear is powered by the left hydraulic system.

3. External stores—Jettison. (P)

CAUTION

When the pylon tanks are jettisoned either manually or electrically (gravity drop), minor damage to the airplane may result.

4. Tip tank dump button—Depress. (P)

WARNING

Complete dumping of tip tank fuel requires up to a full minute; therefore, the weight reduction is gradual rather than instantaneous.

5. Engine fire selector switch for dead engine—Raise guard and actuate. (P)
6. Agent discharge switch—As required. (P)

SINGLE-ENGINE SERVICE CEILING



NO EXTERNAL LOAD

NOTE: ALL ALTITUDES ARE PRESSURE ALTITUDES IN FEET

GROSS WEIGHT POUNDS	ALTITUDE STD DAY 59°F (15°C) AT SL			ALTITUDE HOT DAY 100°F (38°C) AT SL		
	96% RPM WITHOUT AB	100% RPM WITHOUT AB	100% RPM WITH AB	96% RPM WITHOUT AB	100% RPM WITHOUT AB	100% RPM WITH AB
42,000	9800	12,500	24,450	1100	8500	21,450
38,000	13,000	14,850	27,700	7400	11,300	24,650
34,000	16,450	18,000	31,160	12,900	14,300	27,900
30,000	20,200	21,600	34,850	16,900	17,400	31,400

DATA AS OF: 15 MARCH 1956

DATA BASIS: FLIGHT TEST

D-50(2)

7. If obstacle must be cleared, hold airspeed at minimum safe value above stall to maintain best angle of climb. (P)

8. After obstacle is cleared, allow airspeed to increase to 160 knots. (P)

9. Wing flap lever—UP at 160 knots IAS; emergency flap switch (Groups 1 through 35 airplanes)—ON (if left engine is inoperative). (P)

WARNING

Do not raise wing flaps below 160 knots IAS because maximum lift will be reduced, possibly below the minimum required to maintain altitude.

10. Trim—As required. (P)
11. Throttle (inoperative engine)—CLOSED. (P)
12. Crossfeed switch—ON (OPEN). (P)
13. Generator switch for inoperative engine—OFF. (P)

Inflight (Left or Right Engine).

1. Both throttles—Full OPEN. (P)

2. Gear and flaps—Retract. (P)
3. Throttle (inoperative engine)—CLOSED. (P)
4. Engine fire selector switch (inoperative engine)—Actuate. (P)
5. Agent discharge switch (inoperative engine)—As required. (P)
6. Generator switch (inoperative engine)—OFF. (P)
7. Inverter switches—As required. (P)
8. Electrical equipment (nonessential)—OFF. (P—RO)
9. Crossfeed switch—ON (OPEN). (P)
10. Fuel tank switches (tanks with fuel only)—ON. (P)
11. Fuel selector switches—ALL TANKS. (P)
12. Operating engine—Adjust power. (P)
13. Trim condition—Check. (P)

Continued Flight Impossible.

1. Warn radar observer of impending forced landing. (P)
2. Lower nose to maintain flying speed. Prepare to land straight ahead if possible. Alter course only to miss obstacles. (P)
3. External stores—Jettison. (P)

MAXIMUM WEIGHTS FOR CONTINUED FLIGHT AFTER ENGINE FAILURE ON TAKEOFF

NO EXTERNAL LOAD

WEIGHT IN POUNDS AT WHICH 100 FEET PER MINUTE RATE OF CLIMB CAN BE MAINTAINED WITH GEAR DOWN, FLAPS IN TAKEOFF POSITION, AND MAXIMUM POWER

FIELD ELEVATION FEET	AMBIENT TEMPERATURE			
	-10°C (+14°F)	+10°C (+50°F)	+30°C (+86°F)	+50°C (+122°F)
• 5000	40,400	37,150	32,000	25,800
• 4000	42,000	38,550	33,300	26,900
• 3000	42,300	39,950	34,600	28,050
• 2000	42,300	41,350	35,950	29,150
• 1000	42,300	42,300	37,250	30,300
• SEA LEVEL	42,300	42,300	38,550	31,400

DATA AS OF: 15 MARCH 1956

DATA BASIS: FLIGHT TEST D-52

Figure 3-3.

CAUTION

When the pylon tanks are jettisoned either manually or electrically (gravity drop), minor damage to the airplane may result.

Note

Tip pod rockets cannot be jettisoned.

4. Landing gear lever—UP. (DOWN if the airplane has been modified in accordance with T.O. 1F-89-615 and T.O. 1F-89-520.) (P)

WARNING

- If the airplane has not been modified in accordance with T.O. 1F-89-615 and 1F-89-520, all forced landings should be made gear-up, unless the forced landing is made on a runway. If the airplane has been modified, all forced landings should be made with the landing gear down regardless of terrain.

- If left engine is inoperative, landing gear will not retract unless airplane is equipped with a left hydraulic system supplemental pump.

5. Wing flaps—As required; emergency wing flap switch (Groups 1 through 35 airplanes)—ON (if left engine is inoperative). (P)

6. Speed brakes—As required. (P)

7. Throttles—CLOSED. (P)

WARNING

Do not dump wing tip fuel as this will increase fire hazard.

- 8. Canopy—Jettison with "T" handle. (P)
- 9. Inertia reel—LOCK. (P—RO)
- 10. Engine fire selector switches—Raise guards and actuate. (P)
- 11. Agent discharge switch—As required. (P)
- 12. Generator switches—OFF. (P)
- 13. Battery switch—OFF just before touchdown. (P)
- 14. When stopped—Abandon airplane. (P—RO)

ENGINE FAILURE DURING FLIGHT.

If an engine fails during flight, investigate to determine the cause before attempting an air restart. It is recommended that the fuel system be checked first for proper operation. If the failure is caused by improper fuel system operation and the condition is corrected, restart the engine. (See Restarting Engine in Flight, this section.) If failure is caused by mechanical breakdown, as may be indicated by engine instruments or excessive vibration, the engine should be shut down. See figure 3-2 for single-engine service ceilings and figures A-9 and A-10 for single-engine operating data. For procedure on shutting down engine in flight, see Single-Engine Procedure, this section.

Note

If both engines fail, turn battery switch to OFF to conserve electrical power needed to operate the right emergency flight control system or the left hydraulic system supplemental pump. If failure of both engines can be anticipated, all radio communications should be made before failure occurs.

WARNING

If both engines fail on an airplane equipped with supplemental pump, battery switch must be turned to ON again to operate pump.

RESTARTING ENGINE IN FLIGHT.

For best starting conditions, wherever practical, attempt air starts at 20,000 feet or below. However, successful air starts have been made up to 30,000 feet.

Note

Before a restart is attempted and the igniter plugs are energized, fly the airplane in a nose-high attitude (5 to 10 degrees above the horizontal) to drain excess fuel from engine.

An air start can be made if the engine rpm is at least 12.5% and the airspeed is approximately 170 to 250 knots IAS. If both engines have failed, no attempt should be made to restart both engines at the same time. Immediately upon experiencing a double flame-out, turn off all unnecessary electrical equipment, including the power inverter, and descend to 20,000 feet, if practical, before attempting a restart. Battery power may be insufficient to provide for simultaneous ignition and starter power for both engines. Select NOSE TANK by turning the fuel selector switch through the OFF position. This will cause relays and valves to recycle and may clear up the difficulty. Turn on main

power inverter, for engine ignition, and restart one engine (rpm and exhaust gas temperature stabilized), then restart the other using the same procedure. The following procedure should be followed for all air starts:

CAUTION

- Failure to windmill at least 12.5% rpm indicates damage to an engine. Under this condition do not attempt an air start.
 - When operating on spare power inverter on Groups 1 through 30 airplanes, place the sideslip stability augments switch at OFF before attempting an air start, otherwise the load limit of the spare inverter will be exceeded and damage to the inverter may result.
1. Throttle—CLOSED. (P)
 2. Altitude start switch—ALTITUDE START momentarily. (P)
 3. Throttle—Approximately one-half open until exhaust gas temperature stabilizes, then accelerate to desired rpm. (P)
 4. If starting is unsuccessful, attempt another start at lower altitude. (P)

MAXIMUM GLIDE.

For the distance this airplane will glide, power off, at various gross weights, refer to figure 3-4. During descent, the speed of the windmilling engines will be high enough to supply power to the hydraulic system for normal descent operation of the flight controls, provided that engine rpm on either engine does not drop below 10%. The emergency flight control system or supplemental pump should be used to ensure adequate control for landing; but to conserve battery power, the system should be left off until the airplane descends to 5000 feet.

WARNING

A fully charged battery, at a temperature of 72°F (25°C) will supply power for the operation of the emergency flight control system for a maximum of 12 minutes only if the electrical load is reduced to a minimum. This time is considerably shorter on airplanes equipped with left hydraulic system supplemental pumps.

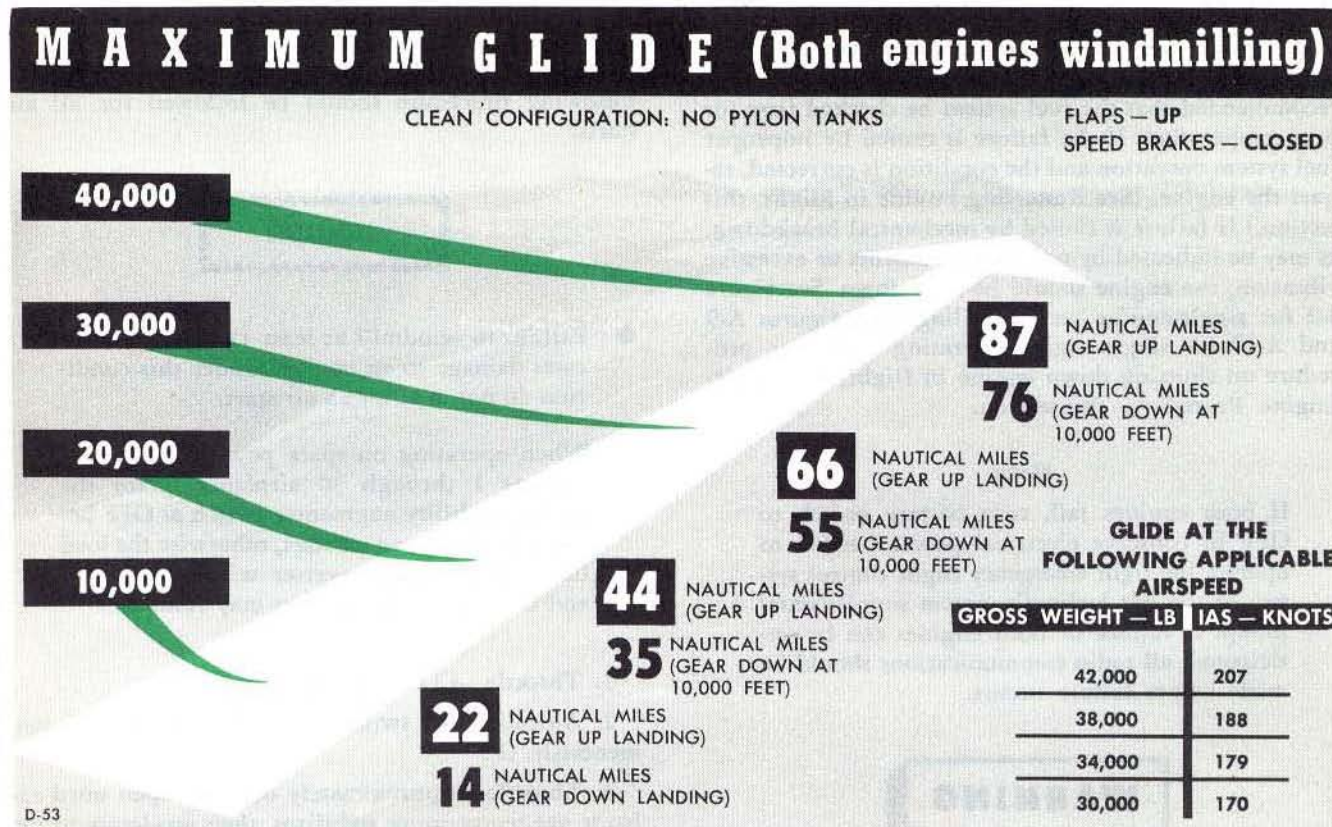


Figure 3-4.

LANDING WITH ONE OR BOTH ENGINES INOPERATIVE.

If a landing with one engine is necessary (figure 3-5), dump tip fuel and drop pylon tanks. Approach the airport at 250 knots IAS using no more than the following engine rpm:

Ambient Temperature	Engine RPM
50°C	93%
30°C	92%
10°C	91%

WARNING

If more than above power is required to sustain level flight at 250 knots IAS, gross weight must be reduced before landing, otherwise reserve power may not be adequate to maintain desired approach path after landing gear and flaps are lowered.

Note

At airspeeds below 160 knots IAS, it may be necessary to lose altitude in order to increase

airspeed. Bear this in mind if single-engine landing becomes necessary and there is the slightest chance that a go-around may be necessary.

If the airplane is not equipped with a left hydraulic system supplemental pump, the radar observer should unstow the hydraulic handpump handle well before entering the pattern. He can normally maintain enough brake accumulator pressure so that the airbrake system need not be used. If, on airplanes not equipped with a supplemental pump, flight control surfaces, speed brakes, and wing flaps are being operated and the left engine rpm is below 80%, the gear can be lowered more quickly by the emergency procedure. The emergency procedure should always be used when engine rpm is below 50%, as reduced pressure may cause delay in gear unlocking. Lowering the landing gear by the emergency procedure will not affect subsequent normal operation. When the gear is lowered by the emergency procedure, the landing gear lever knob will stay lighted, even if the gear is down and safely locked, if the left hydraulic system has insufficient pressure to close the main gear inboard doors. Therefore, the gear position indicators and a visual check should be relied upon for gear position. If the left engine is inoperative on airplanes not equipped with the supplemental pump, wing flaps can be partially extended if the

engine is windmilling. However, extension will be extremely slow and should not be relied upon. Wing flaps are available with either or both engines out on airplanes equipped with the supplemental pump. The downwind leg of the pattern should be extended for a single-engine landing so that a lower than normal approach angle will be flown, thus allowing the use of higher engine rpm in case a go-around is necessary. If it becomes necessary to use the airbrakes, the pilot should apply the brakes carefully since they are very sensitive and effective. Do not pump the brakes since air is lost each time pedal pressure is released.

Right Engine Inoperative.

See Single-Engine Landing Pattern, figure 3-5.

1. Emergency flight control switch—ON (if installed). (P)
2. Decelerate to 195 knots IAS on downwind leg. (P)
3. Landing gear lever—DOWN. (P)

Note

- If, on airplanes not equipped with a left hydraulic system supplemental hydraulic pump, the flight control surfaces, speed brakes, and wing flaps are being operated and the left engine rpm is below 80%, the gear can be lowered more quickly by the emergency procedure. The emergency procedure should always be used when engine rpm is below 50%, as reduced pressure may cause delay in gear unlocking.
 - Lowering the landing gear by the emergency procedure will not affect subsequent normal operation.
4. Wing flap lever—TAKE-OFF. (P)

WARNING

Do not extend flaps below the takeoff position. If flaps are extended lower than takeoff position, they must be raised to at least the takeoff position in case of a go-around. Single-engine go-around with flaps in full down position is impossible because level flight cannot be maintained.

5. Stabilize airspeed at 180 knots IAS. (P)
6. Turn on to final and maintain 160 knots IAS. Fly a lower than normal approach angle so that high rpm can be used. Use of high rpm will reduce the time to obtain maximum power should a go-around be necessary. (P)

7. As end of runway is approached, do not reduce airspeed below 150 knots IAS until landing is assured. (P)

8. Retard throttle to IDLE only when positive of landing. After touchdown, open speed brakes will reduce ground roll. (P)

Left Engine Inoperative.

See Single-Engine Landing Pattern, figure 3-5.

1. Reduce airspeed to 195 knots IAS on downwind leg. (P)
2. Landing gear lever—DOWN. (P)
3. Landing gear emergency release handle—Pull to limit of travel (about 14 inches). The gear will drop of its own weight and will be assisted into fully locked position by the bungee system. (P)

Note

On airplanes equipped with a left hydraulic system supplemental pump, emergency landing gear procedures need not be used.

4. Landing gear position indicators—Check; visually check main gear down. (P)
5. Emergency landing gear release handle—Guide back to stowed position. (P)
6. Wing flap lever—TAKE-OFF. Emergency flap switch (Groups 1 through 35 airplanes)—ON. On airplanes equipped with left hydraulic system supplemental pump wing flap lever—TAKE-OFF. (P)

WARNING

With the left engine windmilling, flap extension will be extremely slow on airplanes not equipped with the supplemental pump.

CAUTION

On Groups 1 through 25 airplanes, do not operate emergency flap system when left hydraulic system is in operation because fluid will be pumped into emergency flap reservoir, causing overflow and loss of fluid. On Groups 30 and 35 airplanes, to prevent possible loss of hydraulic fluid, the emergency flap system includes an automatic hydraulic pressure switch which will hold the emergency flap system electrical circuit open, regardless of the position of the emergency flap switch, until the left main hydraulic system pressure drops below 1700 psi, as it would in case of left hydraulic system failure.

SINGLE - ENGINE

1 DUMP TIP FUEL AND DROP PYLON TANKS IF CARRIED. LEFT ENGINE OUT: HAVE RADAR OBSERVER PUMP BRAKE ACCUMULATOR TO 3000 PSI ON AIRPLANES NOT EQUIPPED WITH SUPPLEMENTAL HYDRAULIC PUMP. RIGHT ENGINE OUT: EMERGENCY FLIGHT CONTROL SWITCH—ON, IF AIRPLANE IS SO EQUIPPED.

8 EXTEND DOWNWIND LEG TO ALLOW LOWER THAN NORMAL FINAL APPROACH ANGLE. THIS WILL PERMIT A HIGHER RPM TO BE USED.

7 CHECK INSTRUMENTS FOR DESIRED RANGES.

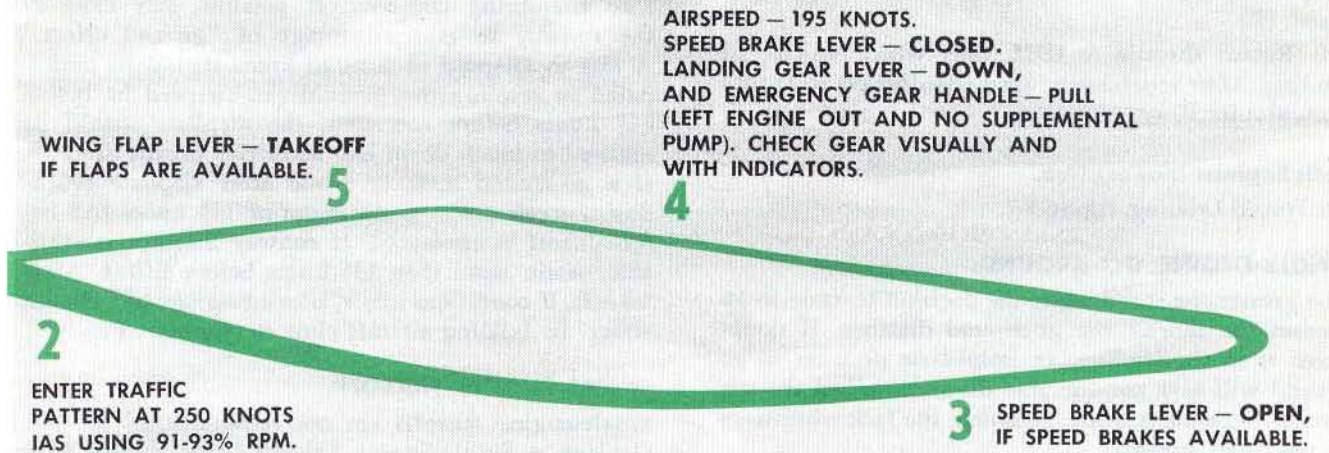
6 STABILIZE AIRSPEED AT 180 KNOTS. TRIM—ADJUST AS AIRSPEED IS REDUCED.

TURN ONTO FINAL AT 180 KNOTS IAS AND STABILIZE AT 160 KNOTS IAS (TAKEOFF FLAPS) OR 169 KNOTS IAS (NO FLAPS).

10 MAINTAIN HIGH ENGINE RPM THROUGHOUT APPROACH.

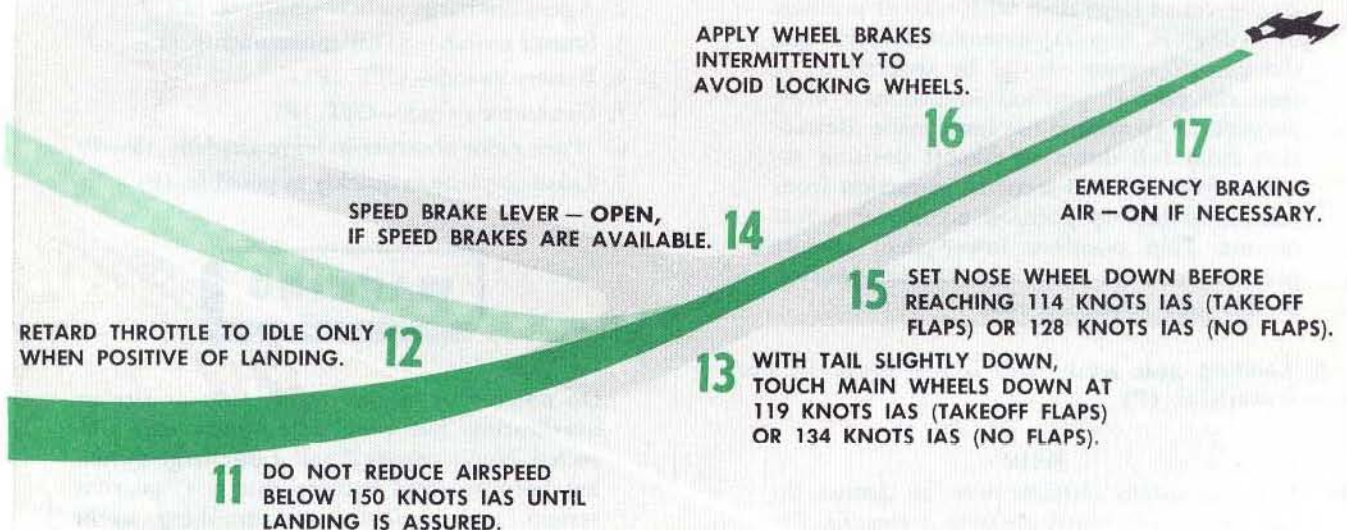
LANDING PATTERN

(Based on a typical gross weight of 33,150 pounds)



WARNING

- AT HIGHER GROSS WEIGHTS, APPROACH AND TOUCHDOWN SPEEDS MUST BE INCREASED. SEE LANDING SPEEDS CHART IN APPENDIX FOR OTHER WEIGHTS AND SPEEDS.
- DO NOT EXTEND FLAPS BEYOND TAKEOFF SETTING FOR A SINGLE-ENGINE LANDING, AS THE AIRPLANE WILL NOT ACCELERATE WITH FULL FLAPS AND ONE ENGINE OPERATING.



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7. Airspeed—Stabilize at 180 knots IAS. (P)
8. Turn on to final and maintain 160 knots IAS. Use a lower than normal approach angle so that high rpm can be used. Use of high rpm will reduce the time to obtain maximum power should a go-around be necessary. (P)
9. As end of runway is approached, do not reduce airspeed below 150 knots IAS until landing is assured. (P)
10. Retard throttle to IDLE only when positive of landing. After touchdown, open speedbrakes to reduce ground roll. (P)

Both Engines Inoperative.

See Forced Landing, figure 3-7.

SINGLE-ENGINE GO-AROUND.

The greater the speed when the decision is made to go around the shorter the go-around distance. If doubt exists as to the landing, an immediate decision to go around will save considerable distance. When the go-around decision is made, complete the following steps in the order given:

1. Throttle on operating engine—OPEN. (P)
2. Afterburner (on operating engine)—ON. (P)
3. Speed brake lever—Check CLOSED. (P)
4. Wing flaps—20 degrees. (P)

WARNING

- Single-engine go-around with flaps in full down position must never be attempted because level flight cannot be maintained.
 - During level flight accelerations at go-around airspeeds, greater acceleration will result with 20 degrees of flaps than with takeoff position of 30 degrees. Any flap extension greater than the takeoff setting should be reduced to at least the takeoff position immediately after decision to go around has been made. Retraction from full down to takeoff position requires from 20 to 25 seconds; retraction from takeoff to full up position takes over a full minute. Flap positions lower than takeoff position must be used with caution because of this long retraction time.
5. Landing gear lever—UP, if left hydraulic pressure is available. (P)

Note

- If an immediate obstacle must be cleared, do not retract gear until obstacle is cleared. Retraction of the gear creates considerable additional drag. If the airplane is accelerating and

no immediate obstacle must be cleared, the gear should be retracted.

- Landing gear should be up and locked and the light in the control handle out before exceeding 195 knots IAS.

6. Allow airplane to accelerate to 160 knots IAS before attempting climbout. If possible, stay close to the runway to take advantage of "ground effect." A loss in airspeed of 5 to 10 knots should be anticipated in leveling out. Should the airspeed be below 145 knots before roundout, the airplane should be allowed to touch down and accelerate on the runway. If a go-around must be made after airplane touchdown, accelerate to a minimum of 135 knots IAS before liftoff is attempted. If runway distance is available, attain more than 135 knots before liftoff. After takeoff, if conditions allow, take advantage of "ground effect" by holding aircraft close to runway. (P)

SINGLE-ENGINE TAKEOFF.

Single-engine takeoffs are not recommended for this airplane. A Single-Engine Takeoff Chart (figure A-5), Critical Field Length Chart (figure A-6), and Maximum Refusal Speeds Chart (figure A-7) are shown in the Appendix. These charts are to be used only for reference if an engine fails during takeoff.

FIRE.

ENGINE FIRE DURING START.

If an engine overheat warning light comes on, close both throttles and keep affected engine windmilling. If the light does not go out, if an engine fire warning light comes on, or if there is any other indication of fire, proceed as follows:

1. Engine fire selector switch for engine on fire—Raise guard and actuate switch. (P)
2. Agent discharge switch—Actuate. (P)
3. Starter switch—STOP momentarily. (P)
4. Battery switch—OFF. (P)
5. Generator switch—OFF. (P)
6. Warn radar observer to leave airplane. (P—RO)
7. Leave airplane as quickly as possible. (P)

WARNING

Do not restart engine until cause of fire or overheating has been determined and corrected. *Never* restart if agent discharge switch has been actuated because this is a one-shot system, and until the extinguishing agent bottle has been replaced, there will be no further fire protection available.

ENGINE FIRE DURING FLIGHT.

If an engine overheat warning light comes on, immediately retard the throttle on the affected engine. If the light then goes out, continue flight with reduced power and land as soon as possible. If the light stays on, if an engine fire warning light comes on, or there is any other indication of fire, proceed as follows:

1. Engine fire selector switch for engine on fire—Raise guard and actuate. (P)
2. Agent discharge switch—Actuate. (P)
3. Oxygen diluter lever—100% OXYGEN. (P—RO)
4. Oxygen regulator emergency lever—Push down momentarily, to clear oxygen mask. (P—RO)

WARNING

Repeated or prolonged exposure to high concentrations of bromochloromethane (CB) or decomposition products should be avoided. CB is a narcotic agent of moderate intensity but of prolonged duration. It is considered to be less toxic than carbon tetrachloride, methyl bromide, or the usual products of combustion. In other words, it is safer to use than previous fire extinguishing agents. However, normal precautions should be taken including the use of oxygen when available.

5. Throttle—CLOSED (on inoperative engine). (P)
6. Generator switch—OFF (for inoperative engine). (P)
7. Do not attempt to restart engine. (P)
8. Land as soon as possible. (P)

WARNING

The "one-shot" fire extinguishing system delivers its entire charge when actuated and must be recharged before it is used again.

FUSELAGE, WING, OR ELECTRICAL FIRE.

If fuselage, wing, or electrical fire occurs, perform the following immediately:

1. Radar equipment—OFF. (P—RO)
2. All electrical equipment—OFF. (P—RO)
3. Eject—If necessary. (P—RO)

SMOKE AND FUME ELIMINATION.

1. Cabin air switch—RAM & DUMP. (P)
2. Oxygen diluter lever—100% OXYGEN. (P—RO)

3. Oxygen regulator emergency lever—Push down momentarily to clear oxygen mask. (P—RO)

EJECTION.

Escape from the airplane should be made with the ejection seat. Follow procedure shown in figure 3-6. Ejection at airspeeds ranging from stall speed to 525 knots IAS results in relatively minor forces being exerted on the body. Ejection at airspeeds of 525 to 600 knots IAS exerts greater forces on the body, making escape more hazardous; and ejection in excess of 600 knots IAS is extremely hazardous because of the excessive forces exerted on the body. Ejection at low altitude is facilitated by pulling the nose of the airplane up above the horizon in a "zoom up" maneuver. Ejection seat velocity is small compared to the velocity of the airplane so that ejection accomplished when the airplane is flying horizontally results in the ejection seat following a nearly horizontal path. A "zoom up" maneuver will result in the ejection seat trajectory coming closer to the vertical, thus effecting an increase in altitude. This altitude gain will increase the time available for separation from the seat and deployment of the parachute. When emergencies necessitate ejections, slow the airplane down as much as possible. Minimum safe level flight ejection altitudes are 2000 feet with a manual belt and parachute, 1000 feet with an automatic belt and manual parachute, 1000 feet with a manual belt opened before ejection and any type of parachute, and 500 feet with an automatic belt and automatic parachute (if the key attached to the parachute timer lanyard is inserted in the belt automatic release).

WARNING

Ejection should not be delayed when the airplane is in a descending attitude and cannot be leveled out, as the chances of successful ejection under this condition at low altitude are greatly reduced.

BEFORE EJECTION.

1. Reduce airspeed as much as possible, and if below 2000 feet, pull the nose above the horizon to reduce airspeed (zoom-up maneuver). (P)
2. Pull handle on bailout bottle if altitude necessitates. (P—RO)
3. Cabin air switch—Ram & Dump. (P)
4. Loose equipment—Stow. (P—RO)
5. If using an automatic-opening parachute, check to make sure the key is attached to the automatic-opening safety belt and the lanyard is free. (P—RO)
6. Canopy—Jettison. (P—RO)

**SIT ERECT, WITH HEAD BACK,
CHIN TUCKED IN, BOTH ARMS ON ARMRESTS
AND FEET FIRMLY ON FOOTRESTS.**

1 GRASP LOOPED
(LEFT) HAND GRIP
AND PULL UPWARD.



2 GRASP LOOPED
(RIGHT) HAND GRIP
AND PULL UPWARD.



WARNING

Minimum safe level flight altitude for ejection is 2000 feet for manually operated safety belt and parachute; 1000 feet for automatic safety belt and manual parachute; 1000 feet with a manual belt opened before ejection and any type of parachute; and 500 feet with an automatic belt and automatic parachute (provided key attached to the parachute timer lanyard is inserted in the belt automatic release).

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Figure 3-6.

EJECTION PROCEDURE

PILOT AND RADAR OBSERVER

3 SQUEEZE FIRING TRIGGER — RIGHT HAND GRIP.



AFTER SEAT CATAPULT FIRES — SEAT BELTS AND SHOULDER HARNESS ARE UNCOUPLED AUTOMATICALLY BY A DELAY INITIATOR.



4 AFTER EJECTION (WITH SAFETY BELT RELEASED) KICK FREE OF SEAT.

WARNING

If time and conditions permit, the radar observer rather than the pilot shall jettison the canopy. This will assure that the radar observer is in position for ejection and will have no difficulty in reaching the ejection seat controls due to wind blast or "G" forces.

WARNING

Keep hands and arms clear of canopy control levers during canopy jettison. As the canopy is jettisoned, the RO's control lever will rotate rapidly to the open position and the pilot's control lever will snap to the UP (open) position.

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WARNING

Keep hands and arms clear of canopy control levers during canopy jettison. As the canopy is jettisoned, the radar observer's control lever will rotate rapidly to the open position and the pilot's control lever will snap to the up (open) position.

EJECTION PROCEDURE.

1. Left handgrip—Grasp and pull upward. (P—RO)
2. Right handgrip—Grasp and pull upward. (P—RO)
3. Firing trigger (on right handgrip)—Squeeze. (P—RO)
4. After ejection (with safety belt released)—Kick free of seat. (P—RO)

FAILURE OF SEAT TO EJECT.

If the ejection seat fails to operate, the following procedure may be used for leaving the airplane:

1. Reduce speed. (P)
2. Oxygen hose, radio equipment, and "G" suit lines—Disconnect. (P—RO)
3. Safety belt—Release. (P—RO)
4. If possible roll airplane on its back and push clear. If it is not possible to roll airplane over, bail out the side of the cockpit towards the aft trailing edge of the wing. (P—RO)

FAILURE OF CANOPY TO JETTISON.

1. Pull the canopy jettison "T" handle. (P)
2. Canopy lock lever—Raise (if step 1 is ineffective). (P—RO)
3. Canopy switch—Move to OPEN (if step 1 is ineffective). As the canopy moves aft from the windshield frame, the airstream will blow it from the fuselage. (P—RO)
4. Continue with normal ejection procedure and eject through canopy (if steps 1, 2, and 3 are ineffective). (P—RO)

AFTER EJECTION.

1. After safety belt releases automatically, kick away from seat. (If automatic release fails, release safety belt manually). (P—RO)
2. If conventional parachute is worn, delay opening to allow body to decelerate so that opening shock will be reduced. If ejection is at high altitude, free fall to normal breathing altitude will reduce the dangers of hypoxia and cold. (P—RO)

WARNING

- With a manually opening safety belt, open the belt prior to ejection under the following conditions: below 2000 feet if position in seat can be maintained; in a dive at high airspeeds up to 5000 feet. Opening the belt prior to ejection will facilitate pulling the "D" ring and opening of parachute after ejection.
- At altitudes higher than 5000 feet do not open safety belt prior to ejection, especially at high airspeeds.
- With an automatic opening safety belt do not open the belt prior to ejection at any altitude. The automatic opening feature will give you the maximum safety factor under all conditions.
- In all ejections below 14,000 feet, manually pull the parachute rip cord grip immediately following separation from the ejection seat. This applies regardless of parachute type, manual or automatic.

LANDING EMERGENCIES.**LANDING WITH FLAPS AND SPEED BRAKES RETRACTED.**

If wing flaps and speed brakes are unavailable for landing, higher touchdown airspeeds must be used to compensate for the lack of extra lift normally supplied by the flaps. If both engines are operative, maintain a minimum of 85% rpm throughout the final approach so that engine rpm can be maintained at as high a setting as possible. Lengthen the downwind leg to provide for a flat final approach. The airplane should be flown strictly by the airspeed indicator throughout the final approach and touchdown. Recommended final approach speeds are as follows:

<i>Gross Weight—Lb</i>	<i>Approach IAS—Knots</i>
30,000	160
34,000	169
38,000	179

Note

The preceding speeds are approximately 5 knots above the stall speeds encountered under average gust conditions.

Touch the main wheels down at the following applicable airspeed:

<i>Gross Weight—Lb</i>	<i>Landing IAS—Knots</i>
30,000	125
34,000	133
38,700	142

Set the nose wheel down before the following applicable airspeed is reached:

<i>Gross Weight—Lb</i>	<i>Landing IAS—Knots</i>
30,000	119
34,000	127
38,700	140

Anticipate a landing roll 25 to 35 percent longer than normal for a dry hard-surfaced runway.

RUNNING OFF RUNWAY ON LANDING.

During the landing roll, if the airplane leaves the runway due to failure of brakes, etc, raise the landing gear by depressing the emergency override lever and simultaneously moving the landing gear lever to UP. If the airplane has been modified in accordance with T.O. 1F-89-615 and 1F-89-520, the landing gear may be left extended if desired.

WARNING

On airplanes not modified in accordance with T.O. 1F-89-615 and 1F-89-520, the pilot should place his feet on the instrument panel during a crash landing to avoid injury. The nose gear strut may come through the floor, causing the control stick to lock his legs in the cockpit.

FORCED LANDING.

If the airplane has been modified in accordance with T.O. 1F-89-615 and 1F-89-520, there is less likelihood of personal injury and extensive damage to the airplane if forced landings are made with gear down, regardless of terrain, to allow the landing gear to absorb initial impact loads. However, unless landing on a runway, gear-down forced landings are recommended only if the airplane has been modified in accordance with T.O. 1F-89-615 and 1F-89-520. Otherwise, the nose gear may cause structural damage to the pilot's cockpit and result in the pilot being trapped in the airplane. If it is necessary to make a forced landing, accomplish as much of the forced landing procedure shown below and on figure 3-7 as possible.

WARNING

Do not raise the helmet visor prior to landing emergencies. Retaining the helmet visor in the lowered position will afford protection

from impact injury, dislodged objects in the cockpit, flame and smoke, and from wind-blown objects if the canopy is jettisoned. The helmet visor is a protection device that should be worn in the lowered position in all landing emergencies.

Note

A two-engine flameout condition may be simulated for practicing forced landings, by retarding the engines to idle rpm, and opening the speed brakes one-third. Stay 1000 feet above terrain.

1. Radar observer—Warn of impending forced landing. (P)
2. Pylon tanks—Jettison. (P)
3. Tip tank fuel—Dump. (P)
4. Throttles—CLOSED if power failure is complete; otherwise, use available power. (P)
5. Landing gear lever—DOWN at 10,000 feet (if airplane has been modified in accordance with T.O. 1F-89-520 and 1F-89-615. UP if airplane is not so modified). (P)
6. Wing flap lever—TAKE-OFF. (P)
7. Parachute—Unbuckle. (P)
8. Safety belt—Tighten. (P—RO)
9. Engine fire selector switches—Actuate. (P)
10. Generator switches—OFF. (P)
11. Canopy—Jettison with "T" handle. (P)
12. Final approach airspeed—Gear up—150 knots IAS; Gear down—140 knots IAS. (P)
13. Battery switch—OFF. (P)
14. Inertia reel lock lever—LOCKED, just before touchdown. (P—RO)

CAUTION

When the shoulder harness inertia reel is locked, either by using the inertia reel lock lever or by jettisoning the canopy, the pilot is prevented from bending forward; therefore, all controls not readily accessible should be positioned before inertia reel is locked.

LANDING WITH GEAR PARTIALLY EXTENDED.

If the landing gear fails to extend completely after both the normal and the emergency procedures have been used, and the landing is to be made on a runway suitable for a normal wheels-down landing, leave as many wheels down as will extend, jettison canopy with "T" handle, and proceed with forced landing. Less damage will result with this procedure than with a gear-up landing. When landing on any type terrain other than a runway, the gear should be retracted unless the airplane has been modified in accordance with T.O. 1F-89-615 and 1F-89-520.

FORCED



1 WARN RADAR OBSERVER.

2 DUMP TIP TANK FUEL AND DROP PYLON TANKS IF CARRIED.

3 THROTTLES — CLOSED IF POWER FAILURE IS COMPLETE; OTHERWISE, USE AVAILABLE POWER.

UNBUCKLE PARACHUTE AND TIGHTEN SAFETY BELT.

6

LOW KEY POINT

2400 FEET AND 150 KNOTS IAS (GEAR UP);
3000 FEET AND 140 KNOTS IAS (GEAR DOWN).

7 ENGINE FIRE SELECTOR SWITCHES — ACTUATE.

5 WING FLAP LEVER — TAKEOFF.

APPROX 2 MILES

GENERATOR SWITCHES — OFF.

8

CANOPY — JETTISON (BY PULLING OUT CANOPY JETTISON T-HANDLE).

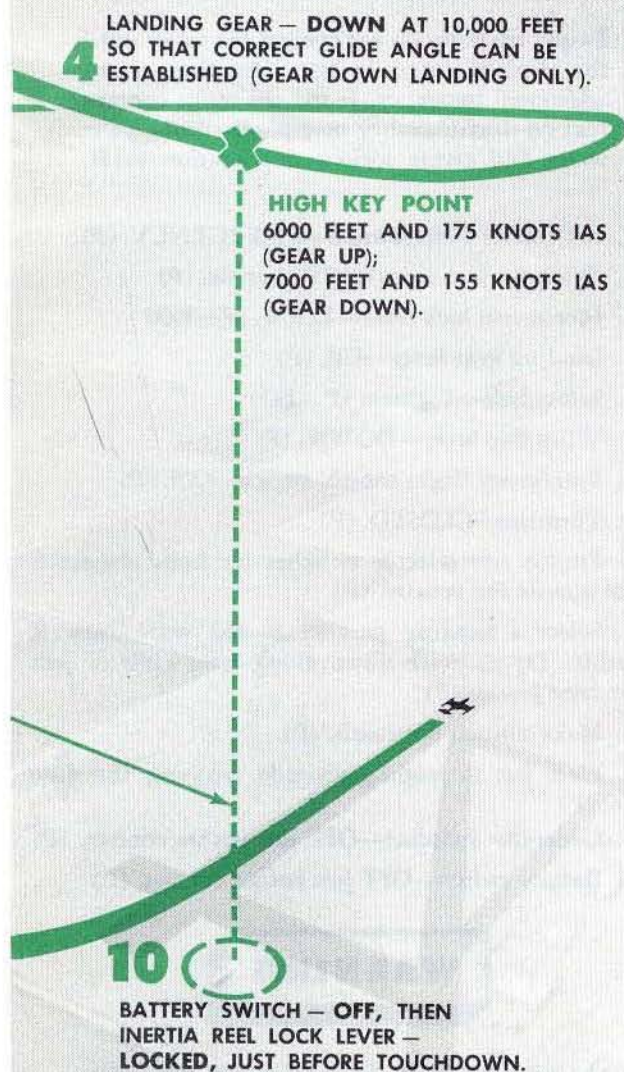
9

NOTE:

- IF TERRAIN IS UNKNOWN OR UNSUITABLE FOR FORCED LANDING, EJECT IN PREFERENCE TO ATTEMPTING TO LAND.
- DESCEND IN A STABILIZED SPIRAL UNTIL READY TO ESTABLISH LANDING PATTERN.

Figure 3-7.

LANDING



AIRPLANES WITH LEFT HYDRAULIC SYSTEM SUPPLEMENTAL PUMP

WARNING: BATTERY LIFE IS EXTREMELY SHORT WHEN OPERATING THE SUPPLEMENTAL PUMP WITH NO GENERATOR CURRENT AVAILABLE. IF THE BATTERY IS IN POOR CONDITION, IT MAY NOT SUPPORT SUPPLEMENTAL PUMP OPERATION. IN THIS CASE, PRESSURE FROM WINDMILLING ENGINES MUST BE DEPENDED UPON FOR FINAL APPROACH AND FLAREOUT. RAPID MOVEMENT OF FLIGHT CONTROLS MUST BE AVOIDED.

GEAR DOWN LANDING

1. TURN OFF BATTERY SWITCH AND LOWER GEAR BY EMERGENCY MEANS IF ALL THREE GENERATORS ARE OUT TO AVOID TURNING ON SUPPLEMENTAL PUMP.
2. TURN BATTERY SWITCH ON AGAIN WHEN ON FINAL APPROACH TO TAKE ADVANTAGE OF SUPPLEMENTAL PUMP HYDRAULIC FLOW WHEN LINING UP FOR LANDING.
3. BATTERY SWITCH — **OFF**; INERTIA REEL — **LOCKED**, IMMEDIATELY BEFORE TOUCHDOWN.

GEAR UP LANDING

DEPRESS NOSE WHEEL STEERING BUTTON ON FINAL APPROACH TO TAKE ADVANTAGE OF SUPPLEMENTAL PUMP HYDRAULIC FLOW.

WARNING: ALL LANDINGS ARE TO BE MADE WITH GEAR DOWN IF THE AIRPLANE HAS THE "WEAK LINK" NOSE GEAR MODIFICATION. AIRPLANES WITHOUT "WEAK LINK" MODIFICATION WILL BE LANDED GEAR DOWN ON A RUNWAY ONLY; IF LANDING ON ANY OTHER TERRAIN, GEAR WILL BE RETRACTED.

AIRPLANES WITH RIGHT HYDRAULIC SYSTEM EMERGENCY FLIGHT CONTROL PUMP

GEAR DOWN LANDING

1. INSTRUCT RADAR OBSERVER TO PUMP HYDRAULIC BRAKE ACCUMULATOR TO 3000 PSI AS SOON AS DECISION IS MADE TO LAND.
2. TURN ON EMERGENCY FLIGHT CONTROL PUMP IMMEDIATELY.
3. LOWER GEAR BY EMERGENCY MEANS TO AVOID DUMPING LEFT HYDRAULIC SYSTEM PRESSURE SUPPLIED BY WINDMILLING ENGINE.

GEAR UP LANDING

TURN ON EMERGENCY FLIGHT CONTROL PUMP WHEN EMERGENCY ARISES.

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LANDING WITH FLAT TIRE.

Because of the comparatively large diameter wheels and small width of tires, directional control of the airplane is easily maintained with rudder and wheel brakes if a main gear tire blows out on landing. If the airplane is landed with one nose wheel tire flat, there will be a slight veering. If a landing is made with both nose wheel tires flat, sufficient up-elevator should be applied to take the weight off the nose wheel and use of wheel brakes should be minimized.

EMERGENCY ENTRANCE.

If it is necessary to gain entrance to the cockpit in an emergency, first attempt to open the canopy by using the external lock lever and canopy switch, both located behind an access door on the left side of the fuselage above the wing leading edge. If the canopy switch fails to open the canopy after it is unlocked, attempt to open it manually using the external hand-grip in the aft structure of the canopy. If this fails, slow jettison the canopy by use of the external emergency canopy release handle, located flush with the fuselage skin just below the access door for the external canopy switch. Pushing the button in the center of the handle will release it. The handle must be pulled out (with a force of about 45 pounds) approximately 5 inches and held (from 10 to 20 seconds) until the canopy is raised above the cockpit rails. The canopy can then be lifted or pushed from the airplane. If all of the foregoing procedures fail; then, as a last resort, chop a hole in the canopy with an ax, using extreme caution not to injure crewmembers inside the cockpit.

EMERGENCY EXIT ON GROUND.

If canopy cannot be opened by the normal procedure and immediate exit is necessary, in an emergency the radar observer can slow jettison the canopy by using the emergency hydraulic pump handle to put pressure against the cable attached to the canopy external jettison lever and the canopy jettison initiator. When pressure is applied to the cable between the control lever and the initiator, the initiator is actuated and the canopy is slow jettisoned. The cable is located in the forward left side of the radar observer's cockpit. If the canopy cannot be slow jettisoned, fast jettison the canopy by pulling the canopy jettison handle (on the pilot's right vertical console) or by raising the right armrest of either ejection seat.

WARNING

General direction of canopy movement when fast jettisoned is straight up. Lack of air-stream may cause it to fall back into the cockpit.

DITCHING.

This airplane should never be ditched if there is sufficient altitude for ejecting safely. Ditching is not recommended because it is assumed that the engine air intake ducts will cause the airplane to dive violently when it hits water. However, if altitude is insufficient for ejecting, warn radar observer, then proceed as follows:

1. Tip tank fuel—Dump. (P)

CAUTION

Empty tip tanks do not contact the water until the airplane comes to rest; then they afford additional buoyancy. If the tip tanks contain fuel on ditching, they may plane through the water and create serious deceleration loads.

2. IFF master control knob—EMERGENCY. (P)
3. Canopy—Jettison with "T" handle. (P)
4. Inertia reel lock lever—LOCK. (P—RO)
5. Landing gear lever—UP. (P)
6. Safety belt—Tighten. (P—RO)
7. Wing flap lever—DOWN. (P)
8. Emergency flight control switch—ON. (P)
9. Throttles—CLOSED. (P)
10. Engine fire selector switches for both engines—Raise guards and actuate. (P)
11. Select a heading parallel to the wave crest if possible. Try to touch down along wave crest or just after crest passes. (P)
12. Make normal approach. (P)
13. Flare out to landing attitude, keeping the nose high. (P)
14. Generator switches—OFF just before contact. (P)
15. Battery switch—OFF just before contact. (P)

WARNING

Do not attempt to ditch in a near level attitude. It is assumed that the airplane will dive violently when the intake ducts hit the water.

OIL SYSTEM FAILURE.

If loss of oil is experienced, the airplane need not be abandoned immediately as a gas turbine engine will not fail directly after loss of oil. An aircraft gas turbine engine depends on oil to cool the roller and ball

bearings, so in the event of oil loss, reduce power to keep temperatures at a minimum. A J-47 engine has been operated at 86% rpm for 17 minutes without oil before destructive engine failure, and a J-35 engine has operated for 27 minutes under the same circumstances before experiencing destructive engine failure. In most instances, ultimate failure of the engine will not occur within 10 minutes after loss of oil and will be signaled by a steadily increasing vibration. At this time engine shut down should be made to prevent a destructive engine failure that would jeopardize a successful ejection or power off control of the airplane in a landing attempt. In most cases the aircraft has remained controllable during its descent. When oil loss is experienced, the following procedure should be performed immediately:

1. Tip tank fuel—Dump. (P)
2. "G" forces—Minimize. (P)
3. Power setting (affected engine)—Minimum. (P)
4. Land at nearest airbase. (P)

FUEL VENT SYSTEM MALFUNCTION (GROUPS 1 THROUGH 70 AIRPLANES).

Under certain conditions of fuel vent or transfer system malfunction, fuel may be lost overboard through a sump tank vent. If fuel overboarding occurs, use the corrective procedures described in the following paragraphs.

FUEL OVERBOARDING DURING CLIMB.

Overboarding of fuel during a climb indicates mechanical failure of a sump tank dive valve in the open position. When this condition occurs, the airplane should be leveled immediately. If the fuel venting stops, malfunction of a dive valve is confirmed. If fuel overboarding starts again if another climb is made, wing tanks should be selected and the airplane landed as soon as possible.

Note

Since the vents for both the left and right sump tanks are located adjacent to each other the tank that is overboarding fuel cannot be determined.

FUEL LEVEL CONTROL SHUTOFF VALVE MALFUNCTION.

If water freezes in a sump tank fuel level control shutoff valve during normal fuel sequencing (ALL TANKS selection), the valve will not close fully when the sump tank is full. As a result, fuel is forced overboard through the sump tank vent line. (This condition will also exist if foreign matter other than ice accumulates in the sump tank shutoff valve.) To correct this condition, the inboard and outboard tank switches for one fuel system, then the other, should be simultaneously

cycled on and off. The resultant surges of fuel from the wing tanks may free the valve in the malfunctioning sump tank. If the valve remains stuck, a wing tank selection should be made and the airplane landed as soon as possible.

FUEL SYSTEM EMERGENCY OPERATION. (GROUPS 1 THROUGH 70 AIRPLANES).

SUMP TANK BOOSTER PUMP FAILURE.

If the normal booster pump in a sump tank fails, the wing tank fuel can be routed directly to the engine by placing the fuel selector switch at WING TANKS. When the wing tanks are empty the selector switch should be placed at ALL TANKS (NOSE TANKS must not be selected when sump tanks are more than two-thirds full because of aft cg limitations). At low altitude, fuel will flow by gravity from the sump tank. If electrical power fails, the wing tanks will not feed to the sump tanks; but at 10,000 feet or below, gravity will supply fuel from the sump tanks to the engine-driven pumps, and the pressurized tip tanks (or pylon tanks) will replenish the sump tanks until the tip tanks are empty. Above 10,000 feet, vapor lock may result; therefore, descent to a lower altitude should be made as quickly as possible to avoid flameout.

WING TANK BOOSTER PUMP FAILURE.

If the booster pump in a wing tank fails during automatic sequencing, the warning light for that tank will come on. The other wing tank on the same side will continue to supply fuel to the sump tank. During normal sequencing, the fuel in the wing tank with the inoperative booster pump cannot be used. However, at low altitude and reduced power, the tank will gravity feed to the engine if the tank selector is set at WING TANKS and the other wing tank on the same side is empty or its tank switch is at OFF.

FUEL PUMP FAILURE.

If an engine-driven fuel pump fails on Groups 1 through 20 airplanes, as may be indicated by a sharp drop in fuel pressure or loss of power, shut down the engine. Turn the crossfeed switch to ON so all remaining fuel can be used by the operating engine.

Note

Fuel will flow faster from the system with the operating engine because of the pressure drop across the crossfeed line. A slight wing heaviness toward the inoperative engine may develop, but will not be critical.

On Group 25 and subsequent airplanes, the engine-driven fuel pump has two pumping elements. If one element fails, the other element will continue to supply adequate pressure. Warning lights are provided to

indicate that one or both elements have failed. These lights are for ground check only; they will not operate when airborne.

DAMAGED TANKS.

If tanks are damaged or a severe leak is suspected, take corrective action as described in following paragraphs.

Damaged Sump Tank.

If a leak is known to be in a sump tank:

1. Fuel selector switch—ALL TANKS (use sump tank fuel first). (P)
2. Wing tank switches—OFF. (P)
3. Nose tank booster pump circuit breakers—PULL. (P)
4. Fuel selector switch (after sump tank fuel is used)—WING TANKS. (P)
5. Wing tank switches—ON. (P)
6. Nose tank booster pump circuit breaker—Push (when wing tank fuel is nearly exhausted). (P)
7. Fuel selector switch (when wing tank empty lights come on)—NOSE TANK. (P)

Damaged Tip Tank.

If a tip tank is damaged and pressure is lost, both tip tanks and pylon tanks will be depressurized and fuel cannot be used. Therefore, dump tip tank fuel and jettison pylon tanks.

Note

Tip tank fuel dumping is dependent upon pressure to force the fuel from the tank. When pressure is lost, fuel remaining in the forward section of the tank cannot be jettisoned. Placing the airplane in a climbing attitude and initiating two or more dumping cycles will jettison the most fuel.

Damaged Wing Tank.

If either wing tank is damaged and its booster pump is operative, use the available fuel in the damaged tank first, then use fuel of other tanks. If the damage is such that it creates an obvious fire hazard, shut down the engine on the damaged side.

Damaged Nose Tank.

If the nose tank is damaged to the extent that considerable fuel will be lost (or will have to be consumed out of normal sequence), and the escaping fuel does not create an obvious fire hazard (necessitating ejecting), terminate the flight as soon as possible. Use extreme care when making elevator movements because a light control stick force will be experienced when the fuel weight is removed from the nose section with sump tanks full or nearly full (aft cg).

WARNING

Escaping fuel from a damaged nose tank may enter the air intake duct of an engine and cause the engine to explode.

Damaged Pylon Tank.

If a pylon tank is damaged to the extent that the air pressure is lost, jettison the tank singly using the armament selector switch and the bombs and pylon tanks release button as described in Section I. If the tank is dropped by gravity (instead of the ejector mechanism), fly the airplane at approximately 200 knots IAS to prevent the released tank from striking the wing.

FUEL EMERGENCY OPERATION (GROUP 75 AIRPLANES).

MAIN TANK BOOSTER PUMP FAILURE.

If one of the two main tank booster pumps fails, the remaining pump will continue to supply fuel to the engine and afterburner above 30,000 feet. Depending upon atmospheric conditions, one pump may or may not support afterburning below 30,000 feet.

WING TANK BOOSTER PUMP FAILURE.

Wing tank booster pump failure will be evidenced by wing heaviness or main tank low-level warning lights glowing.

Note

A wing tank selection will support afterburner operation above approximately 10,000-foot altitude; however, a wing tank booster pump failure will cause the related afterburner to shut down without warning when operating on wing tanks selection below approximately 30,000-foot altitude.

If pump failure is caused by an electrical overload condition, the related circuit breaker on the fuel control panel (figure 1-19) will pop out, indicating the failed pump. If no circuit breakers are out and a pump is believed to be inoperative, as evidenced by wing heaviness or low-level warning light, place the fuel quantity selector switch for the system with the heavy wing, alternately at INBD WING and OUTBD WING while observing the related fuel quantity gage; a large quantity of fuel existing in one wing tank after the other wing tank in the same system is empty or nearly empty, will indicate a pump failure in the tank with the most fuel. To use fuel from a wing tank with an inoperative pump, see Gravity Feed, this section.

GRAVITY FEED.

Each fuel system will gravity feed the related engine with sufficient fuel to maintain military power up to an approximate 6000-foot altitude. When fuel is being gravity fed from either or both wing tanks, the airplane must be flown at a 10-degree nose high attitude (for the system that is gravity feeding) to draw the maximum amount of fuel from the wing tanks. To gravity feed fuel from either wing tank, the booster pump in the adjacent wing tank (in the same system) must be shut down by pulling the related circuit breaker. After fuel supply is exhausted from the wing tank during gravity feeding, press the circuit breaker IN.

CAUTION

When gravity feeding from the right wing tanks with the fuel selector at WING TANKS, the right main tank is isolated from the system. Caution must be exercised to avoid flame-out after the wing tanks become empty. Use the fuel quantity gage system to anticipate the wing tanks becoming empty; place the fuel selector at ALL TANKS prior to completely emptying the wing tanks.

ENGINE-DRIVEN FUEL PUMP FAILURE.

The engine-driven fuel pump has two individual pumping elements. If either pumping element fails, the remaining pumping element will continue to supply adequate fuel pressure to operate the engine at military power at any altitude. Failure of a pumping element in an engine-driven fuel pump will not affect afterburner operation. Fuel pressure for afterburning is supplied by the booster pumps and afterburner turbine-driven pump. Warning lights located on a bracket attached to the pilot's left console will warn of a pump element failure during ground operation; however, during flight the warning lights are automatically disarmed by a switch on the left main landing gear.

DAMAGED TANKS.

If tanks are damaged or a severe leak is suspected, take corrective action as described in the following paragraphs.

Damaged Main Tank.

1. Main tank fuel—Use first. (P)
2. Fuel selector switch (for damaged fuel system)—ALL TANKS. (P)
3. Wing tank booster pump circuit breakers (for corresponding wing)—PULL. (P)

4. Wing tank booster pump circuit breakers (after main tank fuel is used)—IN. (P)
5. Fuel selector switch—WING TANKS. (P)

WARNING

Escaping fuel from a damaged right main tank (in the nose) may enter the air intake duct of an engine and cause the engine to explode.

Damaged Tip or Pylon Tank.

If a tip tank or pylon tank is damaged and pressure is lost, fuel from the tip and pylon tanks will not be usable. Jettison the pylon tanks and press the tip tank fuel dump button. Two or more dumping cycles may be required to dump fuel from unpressurized tip tanks. Any fuel remaining in the forward section of an unpressurized tip tank will not be dumped.

CAUTION

When the pylon tanks are jettisoned either manually or electrically (gravity drop), minor damage to the airplane may result.

Damaged Wing Tanks.

If either wing tank is damaged and its booster pump is operative, use available fuel in the damaged tank first by pulling out the booster pump circuit breaker of the undamaged wing tank in the same system. If damage is such that escaping fuel causes an obvious fire hazard, shut down the engine on the damaged side.

AFT CENTER-OF-GRAVITY FUEL MOVEMENT.

When fuel is in the tip tanks, weight of the right main tank fuel (located in the nose) is essential to keep the airplane's center-of-gravity within allowable limits. If right main tank fuel is lowered 50 gallons (325 pounds) from full, prior to tip tanks becoming empty, an aft cg warning light on the pilot's instrument panel will come on to warn of an aft cg condition caused by insufficient fuel being transferred into the right main tank. If the aft cg warning light comes on, the pilot must reduce airspeed to Mach 0.65 or below and reduce power on the right engine. If the aft cg warning light stays on and right main tank fuel level continues to drop as noted on fuel quantity gages, immediately place the right fuel selector at WING TANKS. When all fuel is used from the tip tanks, as indicated by the fuel quantity gage system, use remaining fuel in wing and main tanks.

Note

- The aft cg warning light is disarmed by a float switch in the right tip tank when the tank becomes empty. This float switch is only to prevent the warning light from burning after all tip tank fuel is expended. To determine whether any fuel remains in the tip tanks, use the fuel quantity gage system.
- Sustained low-altitude operation at maximum power can cause the rate of fuel consumption from the main tanks to exceed the rate of replenishment from the wing tanks. If the aft cg warning light comes on under these conditions, reduce power on the right engine and/or increase altitude.

ELECTRICAL SYSTEM EMERGENCY OPERATION.

See figures 1-22 and 1-23 for equipment rendered inoperative because of failure of the 28-volt d-c system, the 115-volt alternator system, or the a-c inverter systems. In case of complete electrical failure, do not abandon airplane as control of the airplane can be maintained. Figure 3-8 covers 28-volt d-c generator malfunction for which corrective action may be taken by the pilot.

GENERATOR OVERVOLTAGE.

If the voltage of a generator becomes excessive, an overvoltage relay will cut the generator out of the circuit and a warning light will come on. To return the generator to the circuit proceed as follows:

1. Generator switch—RESET momentarily, then return to ON. If the warning light goes out and remains out, overvoltage was temporary. (P)
2. Generator switch—OFF if warning light remains on. (P)
3. Voltage regulator rheostat knob—Turn toward DEC to reduce voltage. (P)
4. Generator switch—RESET momentarily, then return to OFF. (P)
5. Voltage selector switch—Turn to affected generator. (P)
6. Voltage regulator rheostat knob—Adjust until voltage is slightly above the voltage of the other generators. (P)
7. Generator switch—ON. (P)

GENERATOR FAILURE.

If any one of the three 28-volt d-c generators fails, the remaining two can carry the entire load. If any two generators fail, the secondary bus is automatically disconnected from the electrical system. The remaining generator supplies power to the primary bus only. If all three 28-volt d-c generators fail, the following procedure is recommended.

1. Battery switch—OFF. (P)
2. Battery switch—ON and OFF as required to control the fuel system. (P)
3. All switches not essential to emergency flight—OFF. (P—RO)
4. To dump tip tank fuel—Place battery switch in the ON position, push tip tank dump button and hold for 5 seconds, then place the battery switch in the OFF position. (The tip tank dump valve will remain in the open position until the battery switch is again placed in the ON position.) (P)

See figure 1-22 for power distribution. See figure 3-8 for procedure in case of 28-volt d-c malfunction.

ALTERNATOR FAILURE.

If the 115-volt alternator fails, all the components powered by it will be inoperative except the IFF and the windshield heat. These will be switched to the main power inverter (figure 1-22) and will remain in operation.

INVERTER FAILURE (GROUPS 1, 5, AND 10 AIRPLANES).

If either main inverter fails, its "Main Out" light will come on and the spare inverter will take over automatically. If the automatic changeover fails and the "Both Out" warning light comes on, turn the inverter switch to SPARE. If the light remains on and there is no output voltage, turn the inverter switch to OFF. See figure 1-22 for equipment powered by the inverter systems.

INVERTER FAILURE (GROUPS 15 THROUGH 30 AIRPLANES).

If either main inverter fails, the applicable red warning light will come on. Turn on the spare inverter by turning the inverter switch to SPARE. When the spare inverter starts, the warning light will go out. If the spare inverter fails, the same warning light will come on again; turn the inverter switch to OFF. See figure 1-22 for equipment powered by the inverter system.

INVERTER FAILURE (GROUP 35 AND SUBSEQUENT AIRPLANES).

If the single-phase 750-v (main) inverter fails during normal operation, as indicated by the essential bus warning light coming on, place the single-phase inverter switch at EMER, and the 2500-v (spare) inverter will take over the load of the essential bus. The single-phase secondary No. two bus will be disconnected from the 2500-v inverter; however, the three-phase inverter system will automatically take over the load of the flight computer and the directional indicator (normally powered by the secondary No. 2 bus). If the essential bus warning light comes on again, after emergency operation has been selected, failure of the 2500-v inverter is indicated and the single-phase inverter switch should be placed at OFF.

28-VOLT D-C GENERATOR MALFUNCTION CHART

FIRST INDICATION OF MALFUNCTION

MALFUNCTIONING GENERATOR	OTHER GENERATORS
WARNING LIGHT ON; VOLTAGE 0-3 VOLTS; LOADMETER ZERO	LOADMETER ABOVE NORMAL

OVERVOLTAGE

MALFUNCTIONING GENERATOR	OTHER GENERATORS
COND 1 HIGH LOADMETER READING	LOW LOADMETER READING
COND 2 ZERO OR VERY LOW LOADMETER READING; WARNING LIGHT ON	LOADMETER ABOVE NORMAL

IMPROPER PARALLELING

NOTE: Only those failures for which specific corrective action can be taken in flight are shown. For failures other than those listed here, turn off malfunctioning generators and reduce load on operative generators.

VERIFICATION OF TYPE OF MALFUNCTION

MALFUNCTIONING GENERATOR	OTHER GENERATORS
VOLTAGE OFF SCALE ON HIGH SIDE; LOADMETER ZERO*	LOADMETER ABOVE NORMAL

(READINGS OBTAINED WHILE MALFUNCTIONING GENERATOR RESET SWITCH IS HELD MOMENTARILY AT RESET.)

MALFUNCTIONING GENERATOR	OTHER GENERATORS
HIGH VOLTAGE READING; ZERO LOADMETER READING	LOADMETER ABOVE NORMAL
LOW VOLTAGE READING; ZERO LOADMETER READING	LOADMETER ABOVE NORMAL

(READINGS OBTAINED WHILE MALFUNCTIONING GENERATOR RESET SWITCH IS HELD MOMENTARILY AT RESET.)

CORRECTIVE ACTION:

OVERVOLTAGE

- 1 Place malfunctioning generator switch at ON and immediately return to OFF. This will allow overvoltage condition to trip the generator field control relay, thus preventing possible damage by deenergizing generator field circuits.



***NOTE:** If voltage is normal when generator switch is placed at RESET, overvoltage was momentary and generator can be returned to service by placing switch at ON.

IMPROPER PARALLELING

- 1 DEC INCR Adjust voltage to 28 volts with voltage regulator rheostat knob.
- 2 DEC INCR Place generator switch at ON.
- 3 DEC INCR Check loadmeters for approximately equal load. If necessary, equalize load by adjusting the voltage regulator rheostat knobs.
- 4 Frequently check operation of generator for evidence of further malfunctioning.

NOTE: If generator malfunctioning cannot be corrected, turn generator off and reduce load on remaining generators by turning off nonessential equipment.

Figure 3-8.

WARNING

Failure of both single-phase inverters will render the afterburner and afterburner control circuits inoperative. When this occurs, the throttle-actuated eyelid switches will cause the eyelids to open when the throttles are advanced to OPEN, resulting in very low tailpipe temperatures and extreme loss of thrust. To correct this condition, move the toggle-type afterburner control circuit breakers to OFF (unmarked). The eyelids will then close, with an immediate increase in thrust and a return to normal tailpipe temperature. Maximum power setting available for duration of flight will be 100% rpm without afterburning.

Note

If failure of both single-phase inverters occurs during afterburner operation, afterburning will continue until the throttles are retarded.

If the selected (main or spare) three-phase inverter fails, as indicated by the three-phase inverter warning light coming on, place the three-phase inverter switch at the other position. If the light comes on again, indicating failure of both inverters, place the switch at OFF. See figure 1-23 for equipment powered by the inverter systems.

INSTRUMENT FAILURE.

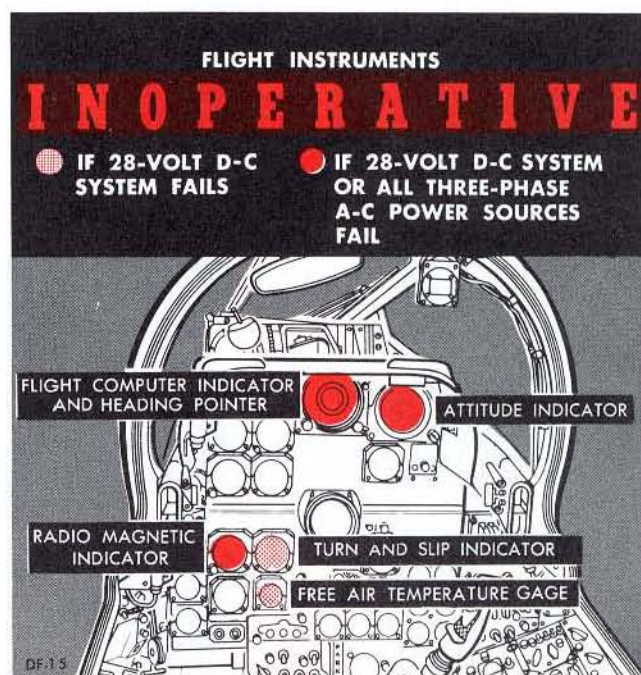
Engine Instruments.

If both the main and spare power inverters fail, all engine instruments will become inoperative except the

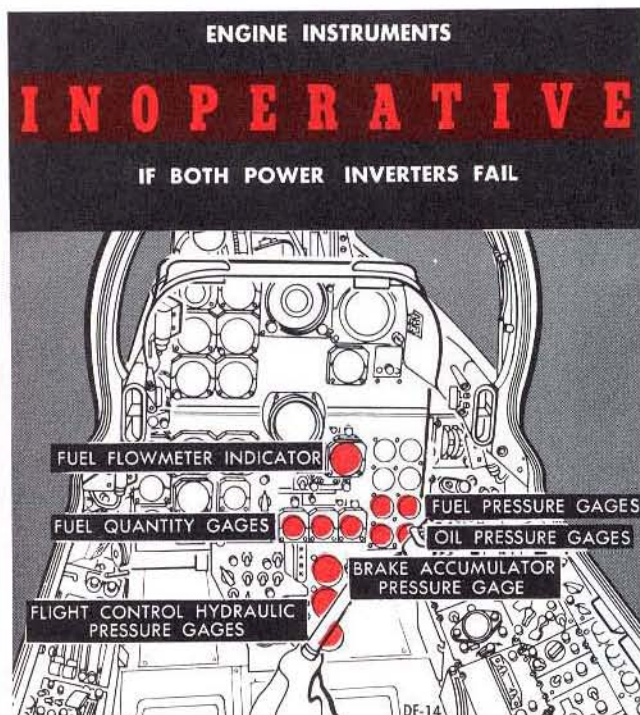
tachometers and exhaust gas temperature gages, both self-generating instruments. The pointers of the oil pressure gages, fuel pressure gages, fuel quantity gages, fuel flowmeter indicator, brake accumulator pressure gage, and left and right hydraulic pressure gages, all powered by the single-phase inverter system, will remain at the last setting indicated before inverter failure.

Flight Instruments.

If all electrical systems fail, the following instruments will remain in operation: vertical velocity indicator,



airspeed indicator, standby magnetic compass, and altimeter. The vertical velocity indicator, altimeter, and airspeed indicators will operate as long as the inlets on the pitot tube and static ports are not iced over. The turn and slip indicator depends on 28-volt d-c power for operation. If both three-phase inverters fail, the attitude indicator will tumble and the radio magnetic indicator will be inoperative. On Groups 1 through 30 airplanes, the directional indicator and flight computer also depend on power from the three-phase inverter system. On Group 35 and subsequent airplanes, the directional indicator and flight computer are powered by the single-phase 2500-va (spare) inverter; if the 2500-va inverter fails, or if emergency operation of the single-phase inverter system is selected, then the directional indicator and flight computer will receive power from the three-phase inverter system. If both single-phase (power) inverters fail, the glide-slope receiver will be inoperative. If the 28-volt d-c system fails, the free air temperature gage needle will fall against the stop, and all instruments depending on power from either the single-phase or three-phase inverter system will be inoperative.



HYDRAULIC SYSTEM EMERGENCY OPERATION.

If the right hydraulic system fails, all hydraulically operated units will operate by pressure from the left hydraulic system; however, flight control operation will be limited in degree and rate of surface movement. To increase the degree and rate of control surface movement during operation of other hydraulic units, turn the emergency flight control switch to ON or depress the nose wheel steering button to start the left hydraulic system supplemental pump, whichever is applicable.

WARNING

With right hydraulic system pressure unavailable, do not operate speed brakes unless

the left engine rpm is at least 85% or, on airplanes so equipped, the supplemental hydraulic pump is operating. At lower rpm the demand on the left hydraulic system by speed brake operation results in limited aileron control unless supplemental pump volume is available.

If the left hydraulic system fails through loss of fluid, the flight control system will operate on the right system pressure, but the degree and rate of surface movement will be limited. Speed brakes will be inoperative. The landing gear, wing flaps (Groups 1 through 35 airplanes), and wheel brakes (if accumulator pressure is not available) must be operated by emergency procedures. If the failure is caused by engine-driven pump failure only, system pressure can be maintained with the supplemental pump on airplanes having the pump; and all units normally operated by the left system will be available, although

HYDRAULIC SYSTEM CAPABILITIES

Under Emergency Conditions

ON AIRPLANES EQUIPPED WITH RIGHT EMERGENCY FLIGHT CONTROL PUMP

HYDRAULIC PRESSURE SOURCE	APPROX. AVG. HYDRAULIC PRESSURE PSI	BASIC CONTROL CONSIDERATIONS (RUDDER, AILERON & ELEVATOR)	GEAR EXTENSION AND RETRACTION CAPABILITIES	FLAP EXTENSION CAPABILITIES	SPEED BRAKE CAPABILITIES
Left system— Right inoperative	3000	Load factor at limit hinge moment decreased by about 0.3 "G"—altitude lost in pullout increased	Normal Extension and retraction about 6 seconds	Normal Extension and retraction for takeoff flaps about 12 seconds	Normal
Right system— Left inoperative	3000	Load factor at limit hinge moment decreased by about 0.3 "G"—altitude lost in pullout increased	Emergency extension 10 to 15 seconds	Flap extension possible if emergency pump is installed—extension to take-off flaps about 35 seconds	Not available
Emergency flight control— Both normal systems inoperative	1500	Satisfactory control at moderate speeds to the stall—limited battery life without the generators	Emergency extension 10 to 15 seconds	Not possible without emergency pump	Not available
Left engine windmilling— Right inoperative	2000 to 700	Possible to land safely—rate of control movement of prime importance due to limited pump capacity	Emergency extension 10 to 15 seconds—handle position for control of pressure bleed not a major consideration (priority valve closes at 1450 psi)	Attempt not advised due to the time involved and possibility of opening the purge valve	No attempt should be made for actuation
Right engine windmilling— Left inoperative	2500 to 900	Possible to land safely—rate of control movement of prime importance due to limited pump capacity	Emergency extension 10 to 15 seconds	Not possible without emergency pump	Not available D-57

Figure 3-9.

rate of response may be somewhat less than normal. Operation of speed brakes, flaps, and gear in rapid sequence should be avoided. Use of nose wheel steering should be held to a minimum because of the high volume of fluid required. If partial failure occurs through the failure of an engine but the engine is still windmilling, pressure can be expected to vary between 700 and 200 psi. Care should be taken not to allow the pressure to bleed below approximately 600 psi. This allows a slight margin above the purge valve setting of 300 psi. When this valve opens, pump flow is routed to the return line with the resultant loss of the system. The only means for closing the valve would be to increase engine rpm to about 38% if the left system does not have the supplemental pump. Engine windmill speeds to be expected are approximately 16%, 12%, and 9% rpm for 175, 140, and 100 knots IAS respectively. With hydraulic pressure available from one windmilling engine, if extreme caution is taken in rate of control movement, the following can be completed *independently*: extension of flaps partially or fully (if left engine is windmilling), correction for slight turbulence, 30-degree bank turns, and flareout for landings. If both hydraulic systems fail, flight controls can be operated by the emergency flight control system if the right system has not failed through loss of fluid and the airplane is equipped with an emergency flight control pump; landing gear can be lowered but not raised; speed brakes cannot be operated; wing flaps (Groups 1 through 35 airplanes) must be operated by emergency procedures; and wheel brakes can be operated only as long as accumulator pressure remains unless the emergency air system is used. Figure 3-9) is a summary of hydraulic system capabilities under emergency conditions.

FLIGHT CONTROL SYSTEM EMERGENCY OPERATION.

If the right or left hydraulic system fails, one 3000-psi hydraulic system is available for basic flight control. Normally, little difference will be noted with flight under such conditions. This includes flight at maximum level flight speed down to stall for the landing configuration. Due to limited elevator deflection, available load factor is lowered by approximately 0.3 "G." A limit in surface deflection occurs when there is a balance in elevator power and airloads (limiting elevator hinge movement). This means that time for recovery from a dive is slightly extended with only one hydraulic system operating. Under 0.80 true Mach number, longitudinal control to limit load factor or airplane buffet is available. Full basic control of the airplane is possible in flight using the 1500-psi emergency hydraulic system pump or the supplemental pump, depending upon which is installed in the airplane. Pilot stick and pedal actuating forces are comparable to those which occur with the normal system in

operation. The emergency pump or supplemental pump replenishing rate is sufficient to maintain pressure during fast actuation of the control surfaces, as would occur during flight in turbulent air. Battery life, when supporting both the emergency flight control pump or supplemental pump and limited use of the radios, is short. For this reason it is suggested that the emergency flight control or supplemental pump be used only when absolutely necessary if 28-volt generator power is unavailable. With only the hydraulic pressure of one windmilling engine available, a safe landing can be executed; however, it is necessary to exercise extreme caution in the rate of control movement. The engine-driven hydraulic pump replenishing rate at engine windmill speeds is low, but full control deflections applied at a slow rate, as necessary for a crosswind landing, are possible. During flight in moderate to heavy turbulence, basic stability should be depended upon to a great extent for maintaining the selected attitude. See figure 3-9.

WARNING

With right hydraulic system pressure unavailable, do not operate speed brakes, unless left engine rpm is at least 85% or, on airplanes so equipped, the supplemental pump is operating. At lower rpm, the demand on the hydraulic system made by speed brake operation will result in limited aileron control unless supplemental pump volume is available.

SIDESLIP STABILITY AUGMENTER EMERGENCY OPERATION.

If the sideslip stability augmenter system fails, causing the airplane to oscillate violently, turn the sideslip stability augmenter switch to OFF. With the sideslip stability augmenter off, damping of the "Dutch Roll" oscillation is extremely light under many flight conditions, but can be controlled by the pilot. Damping can be improved by descending to a lower altitude.

Note

On Group 50 and subsequent airplanes equipped with the modified sideslip stability augmenter, if there is a malfunction of the electronic control unit, making the stability augmenter system inoperative with the rudder trim switch in AUTO TRIM position, move the switch to MANUAL TRIM. If the power

amplifier is still operative, the system will continue to provide satisfactory damping of "Dutch Roll" oscillations but may require some manual adjustment of the rudder trim knob.

WING FLAP SYSTEM EMERGENCY OPERATION.

On Groups 1 through 35 airplanes, if the left hydraulic system fails, or if the wing flaps cannot be operated normally, place the emergency flap switch to ON and move the wing flap lever to the desired position. Flaps will extend to the takeoff position in about 35 seconds. Group 40 and subsequent airplanes are not equipped with an emergency flap system; however, extension is possible under 150 knots IAS if the left engine is windmilling. This procedure is not recommended because of the long extension time involved and the danger of opening the purge valve with resultant loss of the system. See figure 3-9.

CAUTION

On Groups 1 through 25 airplanes, do not operate emergency flap system when left hydraulic system is in operation because fluid will be pumped into emergency flap reservoir causing overflow and loss of fluid. On Groups 30 and 35 airplanes, to prevent possible loss of hydraulic fluid, the emergency flap system includes an automatic hydraulic pressure switch which will hold the emergency flap system electrical circuit open, regardless of the position of the emergency flap switch, until the left main hydraulic system pressure drops below 1700 psi, as it would in case of left hydraulic system failure.

SPEED BRAKE SYSTEM EMERGENCY OPERATION.

The speed brakes cannot be operated if the left hydraulic system fails; however, if the speed brakes are open at the time of failure, they will float back to the streamlined position when the speed brake lever is placed at CLOSED.

LANDING GEAR SYSTEM EMERGENCY PROCEDURES.

If the normal landing gear lowering procedure fails to extend the gear to a safe condition, the pilot should first try to determine what is causing the malfunction,

then execute the appropriate emergency procedure for lowering the landing gear to a safe landing condition. For example, the pilot can determine if there is flow in the landing gear system by recycling the landing gear lever from DOWN to UP and back to DOWN while watching the left hydraulic system pressure gage for fluctuations. If no fluctuations are indicated on the pressure gage during the check, indicating no flow in the landing gear system, it may be assumed that the landing gear position four-way valve is stuck in the gear-up position. If this occurs, the only way the gear can be lowered is by reducing the left hydraulic system pressure to zero. In order to accomplish this, the left engine must be shut down, flaps partially lowered, speed brakes partially opened, and then the flaps retracted at the same time the speed brakes are closed. This will reduce the left hydraulic system pressure to the point that the system purge valve (figure 1-28) will open automatically (approximately 350 psi) and reduce the system pressure to zero. However, on airplanes equipped with a left hydraulic system supplemental pump, the safety relay circuit breaker in the radar observer's cockpit must be pulled prior to flap and speed brake operation to disarm the pump. After the system pressure has been reduced to zero, the landing gear emergency release handle may be pulled to lower the gear.

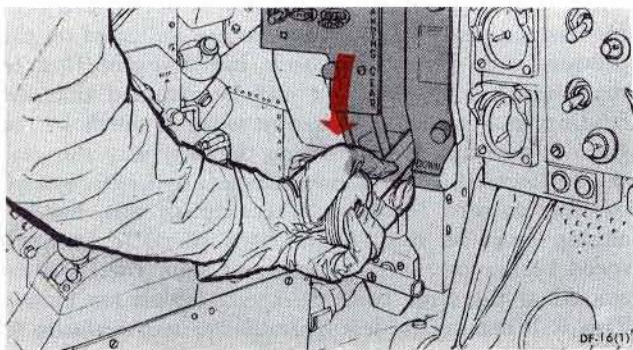
CAUTION

- The left engine must remain inoperative after the landing gear has been lowered by purging the system pressure. If the engine is restarted, left hydraulic system pressure will be restored to normal and the landing gear will retract.
- When using the landing gear emergency release handle, the pilot should make certain the handle is pulled to its full limit of travel (approximately 14 inches). This will assure that all landing gear uplocks have been unlocked. The handle should then be returned to its stowed position. Do not allow the handle to whip back to its stowed position, as damage to cockpit equipment may result.

If any one or all of the landing gears fail to extend after the landing gear lever is placed in the DOWN position and the landing gear emergency release handle has been pulled, the pilot should execute a coordinated maneuver to pull positive "G's". This should be done with the landing gear lever at DOWN and the emergency release handle pulled and held to its full limit of travel. Care should be taken to avoid exceeding the maximum allowable "G's" for the altitude the maneuver is being executed.

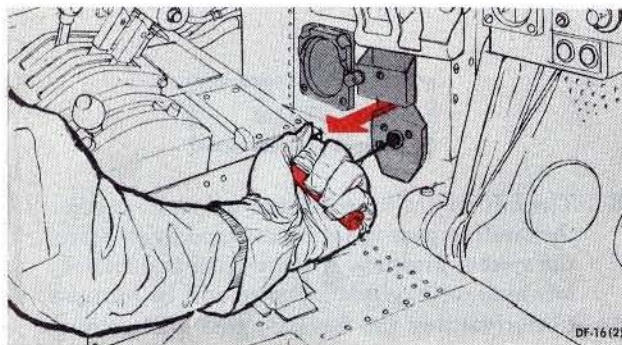
GEAR FAILS TO EXTEND ON NORMAL PROCEDURE.

1. Airspeed—195 knots IAS or below. (P)
2. Landing gear lever—Check full DOWN. (P)

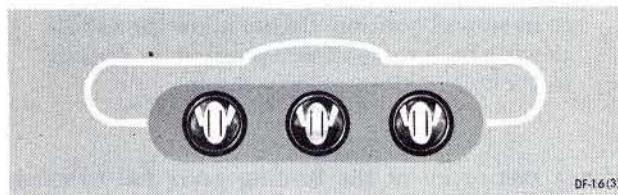


3. Left hydraulic system pressure gage—2000 psi (if pressure is below 2000 psi and time and conditions permit, allow pressure to build up. (P)

4. Landing gear emergency release handle—Pull to full limit of travel (14 inches) and allow at least 30 seconds for gear to extend. (P)



5. Main landing gear—Check visually. (P)
6. Landing gear position indicators—Check for safe indication. (P)

**GEAR FAILS TO EXTEND ON EMERGENCY PROCEDURE.**

1. Airspeed—195 knots IAS or below. (P)
2. Landing gear lever—Recycle, leave in DOWN position. (P)
3. Left hydraulic system pressure gage—Check for fluctuations. (P)

Note

If no fluctuations occur and the pilot is assured that no gears have moved, proceed with the emergency procedure by purging the left hydraulic system.

4. Left engine—Shut down. (P)
5. Safety relays circuit breaker—Pull (airplanes with supplemental pump only). (RO)
6. Flaps—Lower partially. (P)
7. Speed brakes—Open partially. (P)
8. Raise flaps and close speed brakes at the same time, to open the left hydraulic system purge valve. (P)
9. Left hydraulic system pressure gage—Check for 0 psi. (P)
10. Emergency landing gear release handle—Pull (allow at least 30 seconds for gear to extend). (P)

Note

If gear fails to extend, continue with the following procedures.

11. Emergency landing gear release handle—Pull second time and hold at full limit of travel. (P)
12. Pull positive "G's." (P)
13. Main landing gear—Check visually. (P)
14. Landing gear position indicators—Check for safe landing gear indication. (P)

Note

After a prolonged flight at high altitude (where temperature is low) emergency extension may be slower than normal.

Lowering the landing gear by the emergency procedure will not affect subsequent normal operation. Each time the emergency gear extension system is used, the pilot should report it to assure that the system will be properly reset.

BRAKE SYSTEM EMERGENCY OPERATION.

If the left hydraulic system fails, the brakes can still be operated by the accumulator pressure. If necessary, the radar observer can charge the accumulator by placing the forward handpump selector valve (A) at BRAKES, the rear valve (B) at NEUTRAL (see figure 4-8), and pumping the hydraulic handpump. A normal ground roll stop can be made by using accumulator pressure only, provided there is 3000-psi pressure in the system. To stop the airplane using brake accumulator pressure, avoid too many applications which would deplete hydraulic pressure. If wheel brakes fail to respond to brake pedal pressure, release

brakes, immediately push down (some airplanes) and turn the emergency airbrake handle to ON, then operate the brakes as usual. (See figure 3-10.) When applying airbrakes, use caution as pedal resisting forces will be lighter than normally experienced. If both emergency airbrake and brake accumulator pressures are applied to the system simultaneously, more pedal pressure than normal will be required.

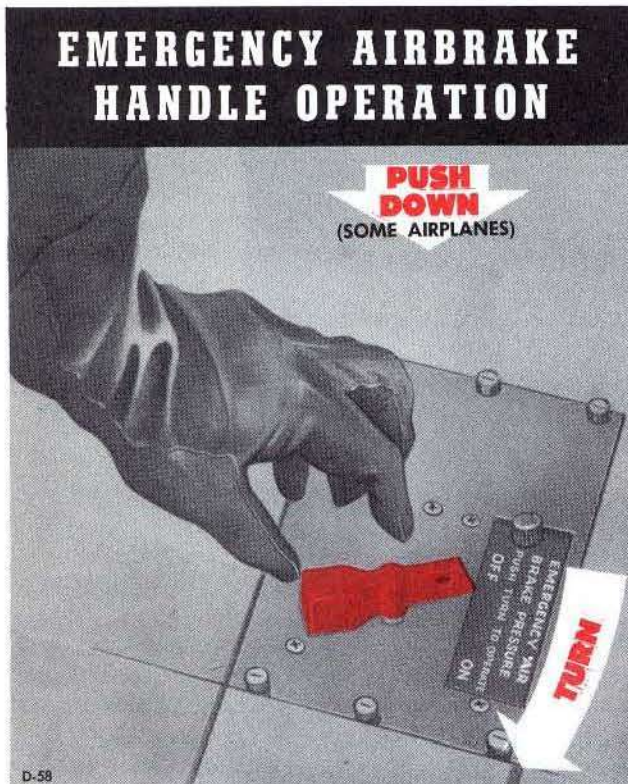


Figure 3-10.

CAUTION

Do not turn emergency airbrake handle to ON while brakes are being applied; sudden increase in braking efficiency may result in a locked wheel and subsequent blowout.

Note

- The air bottle contains sufficient pressure for three complete applications of the brakes.
- Brakes must be bled after using the emergency airbrake system.
- On airplanes modified in compliance with T.O. 1F-89-599 the emergency airbrake handle can be turned without being pushed down.

LOSS OF CANOPY.

If the canopy is lost, the airplane should immediately be decelerated to 200 knots IAS or less. If no other emergency exists, the emergency signal system should be used with prearranged signals, by the pilot and radar observer for intercommunication. On airplanes not equipped with emergency signal systems, local procedure should be developed using the command control shift light or the canopy locking lever to relay messages.

Note

The following pages contain a condensed checklist that has been prepared in a kneepad size for your convenience. This checklist may be removed from the Flight Handbook and carried by you on all flights. Some detailed information normally found in the checklists has been purposely deleted for simplicity and ease of reading; however, all steps and pertinent details are included.





CONDENSED CHECKLIST

CUT ON DOTTED LINE

F-89D PILOT'S CONDENSED CHECKLIST**Note**

The following checklist is a condensed version of the emergency procedures in Section 3.

ENGINE FAILURE.**SINGLE ENGINE PROCEDURE.**

1. Both throttles—OPEN. (P)
2. Gear and flaps—RETRACTED. (P)
3. Throttle (inoperative engine)—CLOSED. (P)
4. Engine fire selector switch (inoperative engine)—ACTUATE. (P)
5. Agent discharge switch—As required. (P)
6. Generator switch (inoperative engine)—OFF. (P)
7. Inverter switches—As required. (P)
8. Unnecessary electrical equipment—OFF. (P—RO)
9. Crossfeed switch (Groups 1 through 70 airplanes)—ON.
Group 75 airplanes—OPEN. (P)
10. Fuel tank switches (Groups 1 through 70 airplanes)—ON. (P)
11. Fuel selector switches—ALL TANKS. (P)
12. Power on good engine—Readjust. (P)
13. Trim for straight and level flight. (P)

ENGINE FAILURE DURING TAKEOFF (BEFORE LEAVING GROUND).**Takeoff Aborted.**

1. Radar observer—Alert. (P)
2. Throttles (both engines)—CLOSED. (P)
3. Speed brake lever—OPEN. (P)
4. Wheel brakes—Apply. (P)
5. Emergency airbrake system—As required. Nose wheel steering button—Depress, on airplanes equipped with left supplemental pump. (P)
6. Canopy—Jettison. (P—RO)
7. Inertia reel—LOCK. (P—RO)
8. Steer for smoothest terrain—As required. (P)
9. Landing gear lever—As required. (P)
10. Engine fire selector switches—Actuate. (P)

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CONTINUED ON NEXT PAGE

CONDENSED CHECKLIST

CUT ON DOTTED LINE

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3. External stores—Jettison. (P)
 2. Airspeed—Check. (P)
 1. Radar observer—Alert. (P)
- Continued Flight Impossible.**

13. Trim condition—Check. (P)
 12. Operating engine—Adjust power. (P)
 11. Fuel selector switches—ALL TANKS. (P)
 10. Fuel tank switches (tanks with fuel only)—ON. (P)
 9. Crossfeed switch—ON (OPEN). (P)
 8. Electrical equipment (nonessential)—OFF. (P—RO)
 7. Inverter switches—As required. (P)
 6. Generator switch (inoperative engine)—OFF. (P)
 5. Agent discharge switch (inoperative engine)—As required. (P)
 4. Engine fire selector switch (inoperative engine)—Actuate. (P)
 3. Throttle (inoperative engine)—CLOSED. (P)
 2. Gear and flaps—Retract. (P)
 1. Both throttles—Full OPEN. (P)
- Inflight (Left or Right Engine).**

13. Generator switch (inoperative engine)—OFF. (P)
12. Crossfeed switch—ON (OPEN). (P)
11. Throttle (inoperative engine)—CLOSED. (P)
10. Trim—As required. (P)
9. Wing flap lever—UP, at 160 knots. (P)
8. IAS (no obstacle)—160 knots. (P)
7. IAS (to clear obstacle)—Minimum safe IAS (best climb angle). (P)
6. Agent discharge switch—As required. (P)
5. Engine fire selector switch (inoperative engine)—Actuate. (P)
4. Tip tank dump button—Depress. (P)
3. External stores—Jettison. (P)
2. Landing gear lever—As required. (P)
1. Radar observer—Alert. (P)

ENGINE FAILURE DURING TAKEOFF (AFTER LEAVING GROUND).

14. When stopped—Abandon airplane. (P—RO)
13. Generator switches—OFF. (P)
12. Battery switch—OFF. (P)
11. Agent discharge switch—Actuate. (P)

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CONTINUED ON NEXT PAGE

CONDENSED CHECKLIST

CUT ON DOTTED LINE

4. Landing gear lever—As required. (P)
5. Wing flaps—As required. (P)
6. Speed brakes—As required. (P)
7. Throttles—CLOSED. (P)
8. Canopy—Jettison. (P—RO)
9. Inertia reel—Lock. (P—RO)
10. Engine fire selector switches—Actuate. (P)
11. Agent discharge switch—As required. (P)
12. Generator switches—OFF. (P)
13. Battery switch—OFF. (P)
14. When stopped—Abandon airplane. (P—RO)

RESTARTING ENGINE IN FLIGHT.

1. Throttle—CLOSED. (P)
2. Altitude start switches—ALTITUDE START, momentarily. (P)
3. Throttle—One-half open until exhaust gas temperature stabilizes, then accelerate to desired rpm. (P)
4. If start is unsuccessful attempt another start at lower altitude. (P)

LANDING WITH ONE OR BOTH ENGINES INOPERATIVE.**Right Engine Inoperative.**

1. Emergency flight control switch—ON (if installed). (P)
2. Airspeed—Decelerate to 195 knots IAS on downwind leg. (P)
3. Landing gear lever—DOWN. (P)
4. Wing flap lever—TAKE-OFF. (P)
5. Airspeed—Stabilize at 180 knots IAS. (P)
6. Turn on to final and maintain 160 knots IAS. (P)
7. Maintain 150 knots IAS until landing is assured. (P)
8. Throttle—Retard to IDLE only when positive of landing. (P)

Left Engine Inoperative.

1. Airspeed—Reduce to 195 knots IAS on downwind leg. (P)
2. Landing gear lever—DOWN. (P)
3. Landing gear emergency release handle—Pull. (P)
4. Landing gear position—Check. (P)
5. Emergency landing gear release handle—STOWED. (P)
6. Wing flap lever—TAKE-OFF. Emergency flap switch (Groups 1 through 35 airplanes)—ON. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

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1. Radar equipment—OFF. (P—RO)

FUSELAGE, WING, OR ELECTRICAL FIRE.

8. Land as soon as possible. (P)
7. Do not attempt to restart engine. (P)
6. Generator switch (on inoperative engine)—OFF. (P)
5. Throttle (on inoperative engine)—CLOSED. (P)
4. Oxygen regulator emergency lever—ACTUATE momentarily. (P—RO)
3. Oxygen diluter lever—100% OXYGEN. (P—RO)
2. Agent discharge switch—ACTUATE. (P)
1. Engine fire selector switch (engine on fire)—ACTUATE. (P)

ENGINE FIRE DURING FLIGHT.

7. Abandon airplane. (P—RO)
6. Radar observer—Warn to abandon airplane. (P)
5. Generator switch—OFF. (P)
4. Battery switch—OFF. (P)
3. Starter switch—STOP momentarily. (P)
2. Agent discharge switch—ACTUATE. (P)
1. Engine fire selector switch (engine on fire)—ACTUATE. (P)

ENGINE FIRE DURING START.**FIRE.**

6. Airspeed—160 knots IAS before climbout. (P)
5. Landing gear lever—UP. (P)
4. Wing flaps—20 degrees. (P)
3. Speedbrake lever—CLOSED. (P)
2. Afterburner (on operating engine)—ON. (P)
1. Throttle (on operating engine)—OPEN. (P)

SINGLE-ENGINE GO-AROUND.

7. Airspeed—Stabilize at 180 knots IAS. (P)
8. Turn on to final and maintain 160 knots IAS. (P)
9. Maintain 150 knots IAS until landing is assured. (P)
10. Throttle—Retard to IDLE when positive of landing. Speed brakes—OPEN after touchdown. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

2. All electrical equipment—OFF. (P—RO)
3. Eject—If necessary. (P—RO)

SMOKE AND FUME ELIMINATION.

1. Cabin air switch—RAM & DUMP. (P)
2. Oxygen diluter lever—100% OXYGEN. (P—RO)
3. Oxygen regulator emergency lever—ACTUATE momentarily. (P—RO)

EJECTION.**BEFORE EJECTION.**

1. Airspeed—Reduce. (P)
2. Bailout bottle—Pull handle. (P—RO)
3. Cabin air switch—RAM & DUMP. (P)
4. Loose equipment—Stow. (P—RO)
5. On automatic-opening parachute—Key attached; lanyard free. (P—RO)
6. Canopy—Jettison. (P—RO)

EJECTION PROCEDURE.

1. Left handgrip—Grasp and pull upward. (P—RO)
2. Right handgrip—Grasp and pull upward. (P—RO)
3. Firing trigger (on right handgrip)—Squeeze. (P—RO)
4. After ejection (with safety belt released)—Kick free of seat. (P—RO)

FAILURE OF SEAT TO EJECT.

1. Airspeed—Reduce. (P)
2. Oxygen hose, radio equipment, and "G" suit lines—Disconnect. (P—RO)
3. Safety belt—Release. (P—RO)
4. Airplane—Roll on its back and push clear, if possible. (P—RO)

FAILURE OF CANOPY TO JETTISON.

1. Canopy jettison "T" handle—PULL. (P)
2. Canopy lock lever (if step 1 is ineffective)—Raise. (P)
3. Canopy switch (if step 1 is ineffective)—OPEN. (P—RO)
4. Eject through canopy (if steps 1, 2, and 3 are ineffective). (P—RO)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

T.O. 1F-89D-1
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1. Tip tank fuel—DUMP. (P)
2. IFF master control knob—EMERGENCY. (P)
3. Canopy—Jettison. (P—RO)
4. Inertia reel lock lever—LOCK. (P—RO)
5. Landing gear lever—UP. (P)
6. Safety belt—Tighten. (P—RO)
7. Wing flap lever—DOWN. (P)
8. Emergency flight control switch—ON. (P)
9. Throttles—CLOSED. (P)
10. Both engine fire selector switches—ACTIVATE. (P)
11. Select a heading parallel to wave crest. (P)
12. Approach—Normal. (P)
13. Flare out to landing attitude. (P)
14. Generator switches—OFF. (P)

DITCHING.

1. Radar observer—Warn. (P)
2. Pylon tanks—Jettison. (P)
3. Tip tank fuel—Dump. (P)
4. Throttles—CLOSED. (P)
5. Landing gear lever—As required. (P)
6. Wing flap lever—TAKE-OFF. (P)
7. Parachute—Unbuckle. (P—RO)
8. Safety belt—Tighten. (P—RO)
9. Engine fire selector switches—ACTIVATE. (P)
10. Generator switches—OFF. (P)
11. Canopy—Jettison (with "T" handle). (P)
12. Final approach airspeed—Gear up—150 knots IAS; Gear down—140 knots IAS. (P)
13. Battery switch—OFF. (P)
14. Inertia reel—LOCKED. (P—RO)

FORCED LANDING.

LANDING EMERGENCIES.

1. Kick clear of seat. (P—RO)
2. With conventional parachute—Delay opening to reduce shock. (P—RO)

AFTER EJECTION.

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

15. Battery switch—OFF. (P)

OIL SYSTEM FAILURE.

1. Tip tank fuel—DUMP. (P)
2. "G" forces—Minimize. (P)
3. Power setting (affected engine)—Minimum. (P)
4. Land at nearest airbase. (P)

FUEL SYSTEM EMERGENCY OPERATION.**DAMAGED SUMP TANK (GROUPS 1 THROUGH 70 AIRPLANES).**

1. Fuel selector switch—ALL TANKS. (P)
2. Wing tank switches—OFF. (P)
3. Nose tank booster pump circuit breakers—PULL. (P)
4. Fuel selector switch (after sump tank fuel is used)—WING TANKS. (P)
5. Wing tank switches—ON. (P)
6. Nose tank booster pump circuit breaker—Push. (P)
7. Fuel selector switch (when wing tank empty lights come on)—NOSE TANK. (P)

DAMAGED MAIN TANK (GROUP 75 AIRPLANES).

1. Main tank fuel—Use first. (P)
2. Fuel selector switch (for damaged fuel system)—ALL TANKS. (P)
3. Wing tank booster pump circuit breakers (for corresponding wing)—PULL. (P)
4. Wing tank booster pump circuit breakers (after main tank fuel is used)—IN. (P)
5. Fuel selector switch—WING TANKS. (P)

ELECTRICAL SYSTEM EMERGENCY OPERATION.**GENERATOR OVERVOLTAGE.**

1. Generator switch—RESET momentarily, then return to ON. (P)
2. Generator switch (if warning light remains ON)—OFF. (P)
3. Voltage regulator rheostat—DEC. (P)
4. Generator switch—RESET momentarily, then return to OFF. (P)
5. Voltage selector switch—Turn to affected generator. (P)
6. Voltage regulator rheostat—Adjust. (P)

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CONDENSED CHECKLIST

CUT ON DOTTED LINE

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1. Airspeed—195 knots IAS maximum. (P)
2. Landing gear lever—Recycle, then DOWN. (P)
3. Left hydraulic system pressure gage—Check. (P)
4. Left engine—Shut down. (P)
5. Safety relay circuit breaker—PULL (on airplanes equipped with supplemental pump. (RO)
6. Flaps—Lower partially. (P)
7. Speed brakes—OPEN, partially. (P)
8. Raise flaps and close speed brakes simultaneously. (P)
9. Left hydraulic system pressure gage—Check for 0 psi. (P)
10. Emergency landing gear release handle—PULL. (P)
11. Emergency landing gear release handle (if gear fails to extend the first time)—PULL and hold. (P)
12. Pull positive "G's." (P)
13. Main landing gear—Check. (P)
14. Landing gear position indicators—Check. (P)

GEAR FAILS TO EXTEND ON EMERGENCY PROCEDURE.

1. Airspeed—195 knots IAS maximum. (P)
2. Landing gear lever—DOWN. (P)
3. Left hydraulic system pressure gage—2000 psi. (P)
4. Landing gear emergency release handle—PULL. (P)
5. Main landing gear—Check visually. (P)
6. Landing gear position indicators—Check. (P)

GEAR FAILS TO EXTEND ON NORMAL PROCEDURE.

LANDING GEAR SYSTEM EMERGENCY PROCEDURES.

1. Battery switch—OFF. (P)
2. Battery switch—ON and OFF as required to control fuel system. (P)
3. All electrical equipment not essential for emergency flight—OFF. (P—RO)
4. To dump tip tank fuel: Battery switch—ON; tip tank dump button—Push and hold for 5 seconds, then battery switch—OFF. (P)

GENERATOR FAILURE (ALL THREE).

7. Generator switch—ON. (P)

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Section IV


Description and Operation of AUXILIARY EQUIPMENT

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CABIN AIR-CONDITIONING SYSTEM.

Air for cabin air conditioning and pressurizing and for canopy defogging is taken from the eleventh stage of the engine compressors. It then flows through a shutoff valve in the supply duct to a bypass valve and refrigeration unit. An electronic temperature-sensing system automatically determines the settings of the bypass valve. Cooled air from the refrigeration unit mixes in the main duct with the hot air bypassing the unit and flows through floor outlets into the cabin. (See figure 4-2.) A cabin temperature rheostat regulates the temperature of the air entering the cabin, and an automatic pressure regulator controls

the pressure. The cabin air-conditioning system is controlled by 28-volt d-c power, and the electronic temperature-sensing system is operated by 115-volt a-c power from the single-phase inverter system.

Cabin Pressure Regulator.

The cabin is not pressurized below 12,500 feet. From 12,500 to 31,000 feet, the air pressure regulator maintains the cabin pressure at the 12,500-foot altitude pressure. Above 31,000 feet, the regulator normally maintains a constant differential pressure of 5.00 psi. For combat operation above 12,000 feet, an alternate differential pressure of 2.75 psi can be selected so that the drop in cabin pressure will not be explosive if

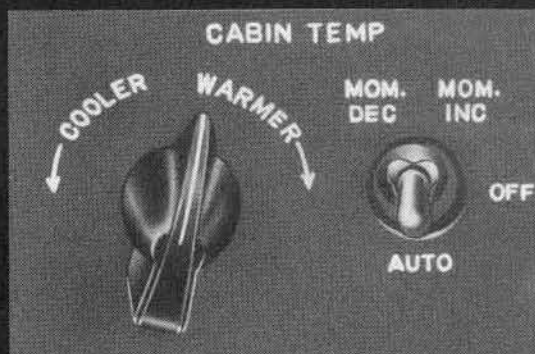
CABIN AIR - CONDITIONING PANELS



GROUPS 1 THROUGH 15 AIRPLANES
(SOME AIRPLANES)



GROUP 20 AND SUBSEQUENT AIRPLANES
AND SOME EARLIER AIRPLANES



GROUP 20 AND SUBSEQUENT AIRPLANES
AND SOME EARLIER AIRPLANES

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Figure 4-1.

the cabin is suddenly depressurized. If the cabin pressure regulator fails, a pressure-vacuum-relief valve relieves excessive pressure. When the airplane dives to an altitude where the outside pressure is greater than that in the cabin, the pressure-vacuum-relief valve opens to equalize the pressure.

CABIN AIR SWITCH.

The 28-volt cabin air switch (figure 4-1) on the pilot's instrument panel controls cabin air and pressure. When the switch is at RAM & DUMP, ram air ventilates the cabin, the engine compressor air is shut off, and the cabin temperature control system is de-energized. When the switch is at PRESS, the ram air is shut off, the engine compressor air is turned on, and the cabin temperature control is energized.

CABIN DIFFERENTIAL PRESSURE SWITCH.

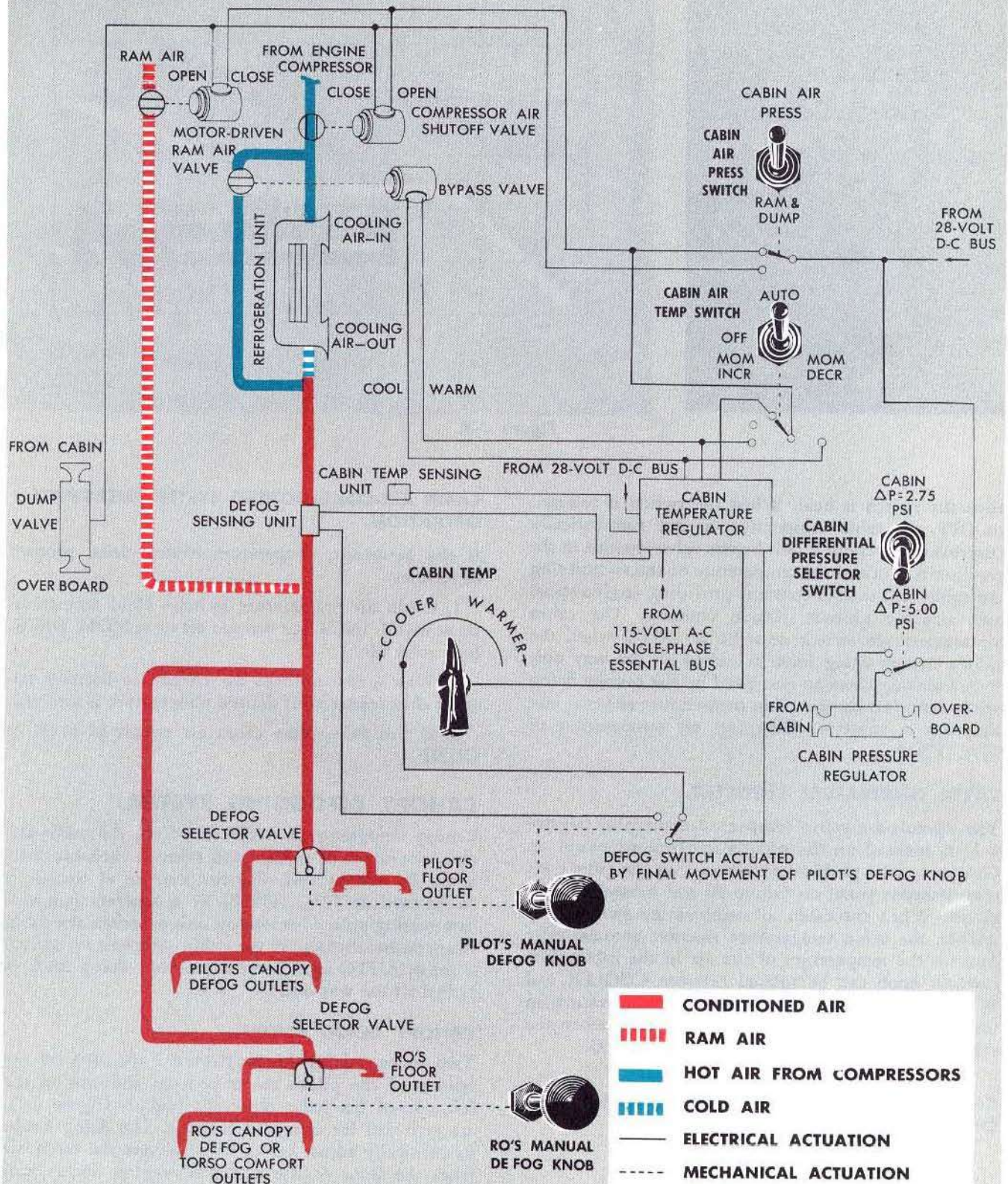
The cabin differential pressure selector switch (figure 4-1), a 28-volt d-c switch on the pilot's instrument panel, provides a means of selecting either of two available cabin pressures. For all normal operations this switch should be at 5.00 P.S.I. so that from 12,500 feet the cabin air pressure regulator will maintain the

cabin pressure at the 12,500-foot level, and above 31,000 feet will maintain a constant differential pressure of 5.00 psi. For combat operations the switch should be moved to 2.75 P.S.I. to minimize any adverse effects if the cabin is suddenly depressurized. (See figure 4-3.)

CABIN AIR TEMPERATURE SWITCH.

The cabin air temperature switch (figure 4-1) provides a means for lowering or raising cockpit temperature and is located on the pilot's instrument panel on Groups 1 through 15 airplanes and on the pilot's aft miscellaneous panel on Group 20 and subsequent airplanes. The cabin air temperature switch operates on 28-volt dc and has a center neutral position marked OFF; other positions are AUTO, MOM. INCR, and MOM. DECR. The switch is spring-loaded to OFF from the latter two positions. When the switch is at AUTO, the cabin temperature is maintained automatically according to the setting of the cabin temperature rheostat. When the switch is held at MOM. INCR. or MOM. DECR, the cabin temperature rheostat is cut out of the circuit and the cabin temperature increases or decreases in proportion to the length of

AIR-CONDITIONING SYSTEM



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Figure 4-2

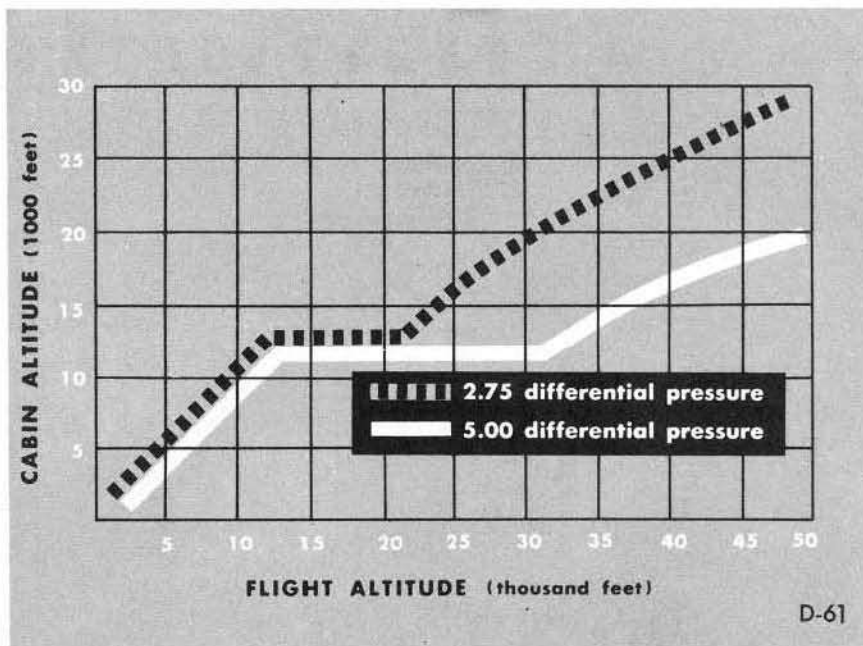
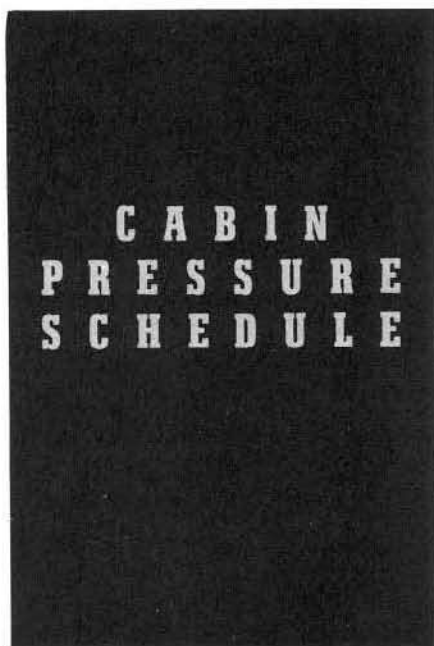


Figure 4-3.

time the switch is held. When the switch is released to OFF, the cabin temperature is not automatically controlled; the cooling unit bypass valve remains in the position it is in and the temperature of the air entering the cabin will remain constant providing engine speed and airplane altitude remain constant. The cabin air temperature switch must be at AUTO when the pilot's canopy defog knob is pulled all the way out; then a sensing element, energized by the canopy defog knob, can override the cabin temperature rheostat and maintain a constant defogging air temperature of 79°C (175°F).

CABIN TEMPERATURE RHEOSTAT.

The 28-volt d-c cabin temperature rheostat (figure 4-1) is located on the pilot's instrument panel on Groups 1 through 15 airplanes and on the pilot's aft miscellaneous panel on Group 20 and subsequent airplanes. When the cabin air temperature switch is at AUTO, the cabin temperature rheostat automatically controls the temperature of the air in the cabin. The rheostat knob can be rotated between COOLER and WARMER as desired to control the temperature in the cabin. The rheostat is out of the circuit when the cabin air temperature switch is not at AUTO.

CABIN AIR-CONDITIONING SYSTEM NORMAL OPERATION.

1. Cabin air switch—PRESS.
2. Cabin air temperature switch—AUTO.
3. Cabin air temperature rheostat—As desired.
4. Cabin differential pressure switch—5.00 P.S.I.

CABIN AIR-CONDITIONING SYSTEM EMERGENCY OPERATION.

If the automatic temperature control fails, proceed as follows:

1. Cabin air temperature switch—Hold momentarily at MOM. INCR. for warmer air or at MOM. DECR. for cooler air.
2. Wait a few minutes for change to become evident; then repeat until desired temperature is attained.
3. If this fails, place cabin air switch at RAM & DUMP.

CANOPY DEFOGGING SYSTEM.

Canopy defogging air is diverted from the cabin air-conditioning floor outlets and released through ducts along the canopy rail. The temperature of the air is maintained at 79°C (175°F) by a separate temperature-sensing unit. This sensing unit overrides the cabin temperature rheostat if the cabin temperature switch is set at AUTO and the pilot's canopy defog knob is pulled all the way out.

CANOPY DEFOG KNOBS.

Two canopy defog knobs (figure 1-10), one on the bottom of the pilot's center pedestal and one on the left side of the radar observer's cockpit (figure 4-7), are provided for canopy defogging. The defog knobs mechanically adjust valves which divert the cabin air from the floor outlets to the defogging ducts. Each crewmember controls canopy defogging for his cockpit, but only the pilot's defog knob can energize the sensing element which overrides the cabin temperature

rheostat and maintains the defogging air at 79°C (175°F). The pilot's defog knob must be pulled all the way out to energize the sensing element, and the cabin temperature switch must be at AUTO to insure automatic control of the air temperature. Turning the knob toward LOCK or UNLOCK increases or decreases the resistance to movement.

Note

On Group 50 and subsequent and some earlier airplanes, the radar observer's defog ducts have been removed and replaced by stub nozzles to improve torso comfort and to eliminate the danger of direct hot air blasts on the canopy. These stub nozzles retain the same flow characteristics as the defog ducts, and flow is controlled by the same radar observer's canopy defog knob.

CANOPY DEFOGGING SYSTEM OPERATION.

The canopy defogging system should always be used immediately prior to and during descents. If high humidities are known to exist at low altitudes (dew point over 60°F) the defogging system should be on for at least 30 minutes prior to descent to insure that the canopy does not fog over at low altitude. When the canopy defogging system is used at low altitudes, correct procedure must be followed to avoid overheating the canopy above its critical temperature of 88.6° to 93.3°C (190° to 200°F). At these temperatures it softens and can fail under the pressure loads that occur during certain flight conditions. The overheating itself does not permanently damage the canopy, for when it cools back below the critical temperature, it regains its original strength. To obtain defogging air at the correct temperature, the following steps should be performed in the order given:

1. Cabin air pressure switch—PRESS.
2. Cabin air temperature switch—AUTO.
3. Pilot's defog knob—Pull all the way out.
4. Radar observer's defog knob—As desired.

CAUTION

The radar observer should check with the pilot to determine that all the pilot's controls affecting defogging are in their correct positions before he pulls his defog control out, to insure controlled operation of the system.

Step 3 fixes the automatic cabin air temperature control at 79°C (175°F) only if steps 1 and 2 have been performed. Failure to perform step 1 will prevent any control of temperature or pressure. Failure to

perform step 2 will leave the defogging air temperature uncontrolled, affected only by compressor air temperature and the position of the refrigeration unit bypass valve. Failure to perform step 3 will leave defogging air temperature uncontrolled, since only at the full out position of the pilot's defog knob will the defog temperature-sensing unit be energized and override the cabin temperature rheostat when steps 1 and 2 have been performed. If the cabin temperature switch is held at MOM. INCR or MOM. DECR, the automatic temperature control is overridden. If the pilot's or radar observer's defogging knob is pulled out when the switch is held at MOM. INCR, air at full compressor temperature is directed on the canopy and damage to the canopy may result. If either knob is pulled out when the switch is held at MOM. DECR, air at the lowest temperature available from the refrigeration unit is directed on the canopy. The use of the defog knobs at intermediate positions (not out far enough to energize the automatic temperature control) when the air-conditioning system is cooling the cockpits will greatly increase cooling effectiveness, since air from the defogging ducts will provide additional cooling to the upper part of the body. Caution must be exercised when the defog knobs are used in this manner since damage to the canopy will result if heating is turned on without returning the knobs to the full in position.

ANTI-ICING SYSTEMS.

THERMAL AND ELECTRICAL ANTI-ICING SYSTEMS.

For the thermal anti-icing system, hot air is extracted from the eleventh stage of the engine compressor to anti-ice the leading edge of the wings, empennage, tip pods, and engine air intake scoop. In normal operation, the hot air maintains a predetermined leading edge skin temperature. The air passes through a pneumatic safety valve and a modulating valve which is controlled by the skin normal thermistors and the pressure control. If the normal thermistors fail to control the modulating valve, and the surfaces of the leading edges overheat, a skin overheat thermistor will close the pneumatic safety valve to stop the flow of hot air to the surfaces. When the temperature then drops below a predetermined value, the overheat thermistor will reopen the safety valve until the surfaces again overheat; then the cycle repeats. The engine inlet guide vanes, bullet nose, island fairings, and forward frame struts are heated by hot air bled directly from the eleventh-stage duct whenever the anti-icing system is in operation. Icing conditions are detected by means of a pressure-sensing icing probe located in each engine air inlet duct. When ice forms on either probe, a 28-volt d-c red warning light on the anti-icing control panel illuminates, the engine screen normal controls are overridden, and the engine screens are retracted. When the airplane is parked with the power on and the anti-icing switch is at

OFF, the warning light will come on and remain on, whether ice is present or not, until the engines attain a speed of 62.5% rpm. Below 62.5% engine rpm the inlet air pressure is insufficient to actuate the pressure switch. Operation of the thermal anti-icing system causes rise in exhaust gas temperature, an increase in specific fuel consumption, and a decrease in available thrust. The electrical controls for the system operate on 28-volt dc. In the electrical anti-icing systems, 28-volt d-c heating elements heat the pitot tubes, angle-of-attack probe, and engine icing probes. The fuel tank vents, calrod heaters in the tip pod rocket doors, and, on Groups 1 through 30 airplanes not modified to T.O. 1F-89D-538, electric blankets in the forward area of the wing pylons are energized by the 115-volt alternator. Anti-icing is necessary to ensure operation of the doors and release mechanisms. The anti-icing switch controls the circuits for all of these electrical heating units except the pitot heaters. When the airplane is on the ground, an oleo ground safety switch on the main landing gear deenergizes all circuits except the pitot heating circuit.

WARNING

Do not use wing anti-icing during takeoff or landing as maximum available thrust will be reduced.

Anti-Icing Switch.

The 28-volt d-c anti-icing switch (figure 4-4) on the anti-icing control panel controls the electrical circuits of the thermal and electrical anti-icing systems. When the red light warns that ice has formed on the engine icing probes, the switch can be turned to TAKE-OFF for engine anti-icing or to FLIGHT for complete anti-icing. When the switch is at TAKE-OFF or FLIGHT, the electric heaters for the icing probes, angle-of-attack probe, fuel vents, and tip pod rocket doors operate when airborne; but, while the airplane is on the ground, the oleo strut ground safety switch breaks the circuits. When icing conditions no longer exist, the anti-icing switch should be turned to OFF to deenergize all anti-icing circuits.

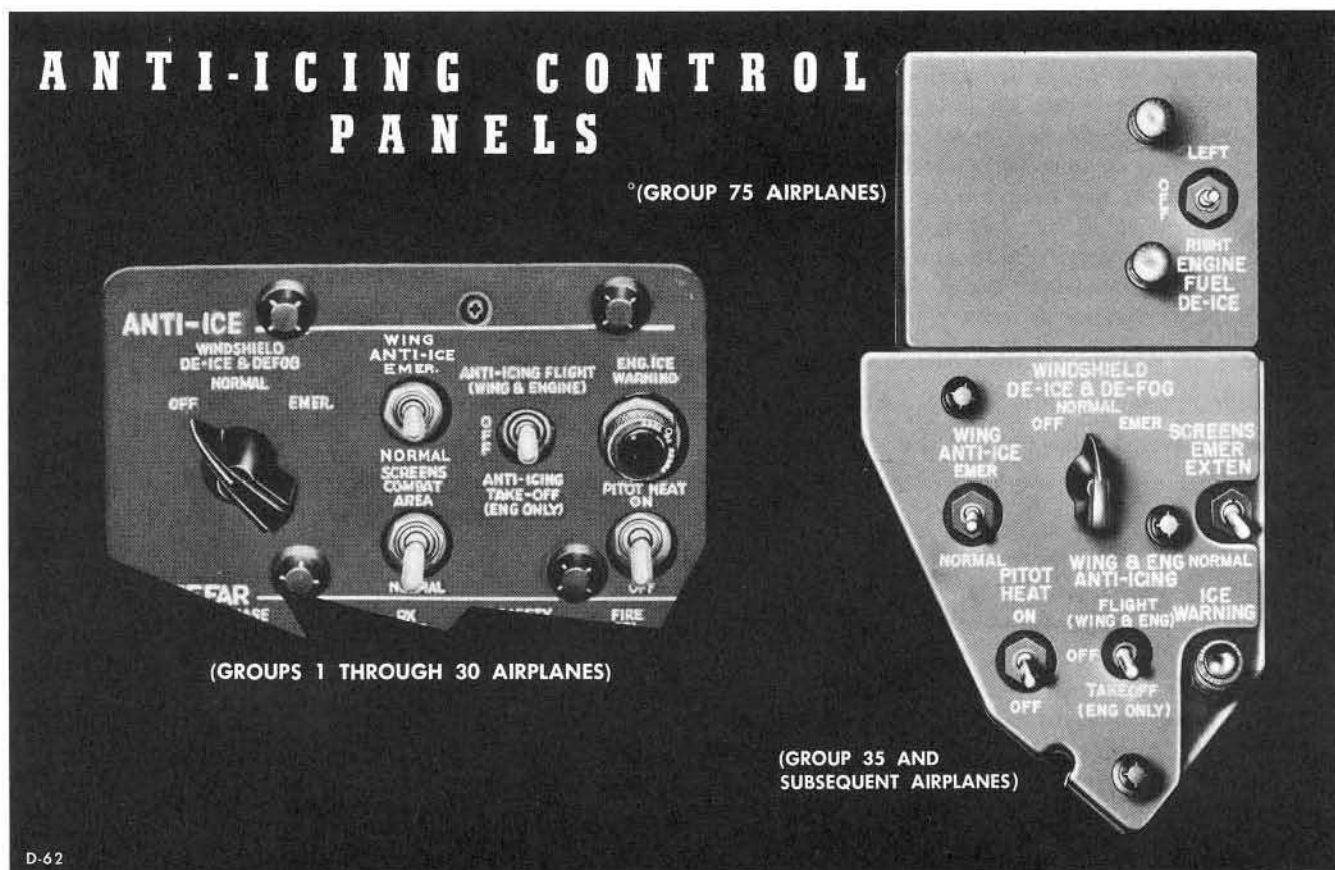


Figure 4-4.

Wing Anti-Icing Override Switch.

A 28-volt d-c wing anti-icing override switch (figure 4-4), located on the anti-icing control panel, provides manual control of the flow modulating valve in the event of failure of the normal thermistor circuit. The switch has two positions: NORMAL and EMER. When the switch is placed at NORMAL, the modulating valve is controlled automatically by the normal thermistors and the pressure control. When the switch is placed at EMER, the modulating valve will open; however, if an overpressure condition exists, the pressure control will prevent the valve from opening regardless of switch position. When the switch is at EMER, the overheat thermistor will continue to control the pneumatic safety valve.

Pitot Heat Switch.

Each pitot tube is heated by 28-volt d-c power. The pitot heat switch (figure 4-4) on the anti-icing control panel can be turned to OFF and ON to control the operation of the pitot heaters. The pitot heat switch is not overridden by the oleo ground safety switch and can be turned to ON at any time.

Engine Screen Switch.

The 28-volt d-c engine screen switch (figure 4-4) on the anti-icing control panel provides a means for extending the engine screens during combat, or at other times when there is danger of foreign matter entering the engine intake ducts. The switch has two positions: NORMAL and COMBAT AREA on Groups 1 through 30 airplanes, and NORMAL and EMER EXTEN on Group 35 and subsequent airplanes. When the switch is placed at NORMAL, the screens extend and retract automatically with the landing gear. When the switch is placed at COMBAT AREA (or EMER EXTEN), the screens extend; however, if anti-icing system operation is selected, the screen control is overridden and the screens retract.

Anti-Icing Warning Light.

When ice forms on the engine probes, the 28-volt d-c anti-ice warning light (figure 4-4) on the anti-icing control panel comes on to indicate that the anti-icing system should be turned on. When the anti-ice switch is turned to TAKE-OFF or FLIGHT, the light goes out and will not come on again while the anti-icing systems are energized. On some airplanes in Groups 1 through 65, when the anti-ice switch is on TAKE-OFF or FLIGHT, the heating elements for the icing probes are energized unless the circuits are broken by the landing gear strut ground safety switch. The probe heaters operate until the anti-ice switch is turned to OFF; then the probe heaters are deenergized and the warning light will come on if ice again forms on the probes. On Group 70 and subsequent and some earlier airplanes, the probe heater circuits have been modified to provide intermittent probe heat. When the

anti-ice switch is at TAKE-OFF or FLIGHT, and ice forms on the probes, the probe heating elements are automatically energized until the ice melts; they are then automatically deenergized. This cycle will be repeated as long as the engine icing condition exists, the anti-ice switch is placed at OFF, or the circuit is broken by the landing gear strut ground safety switch.

Anti-Icing System Operation.

The following operating procedures are recommended for use of the anti-icing system in conditions of known icing or when indicated by the ice warning light.

Takeoff. Select TAKE-OFF position of anti-icing switch. This will retract the engine inlet screens and provide hot air anti-icing of the engine forward frame components.

WARNING

- Unless the anti-icing switch is placed at TAKE-OFF when taking off into icing conditions, the engine screens will remain extended until the airplane leaves the ground. In severe icing conditions the engine screens may become iced within a few seconds, resulting in dangerous loss of power.
- FLIGHT position of anti-icing switch is not to be used on takeoff, because complete airplane surface anti-icing increases the demand on the compressor hot air bleed and causes a much greater loss in thrust.

In Flight (Level Flight and Climb). Select FLIGHT position of the anti-icing switch. This will retract the engine inlet screens if screen switch is in COMBAT AREA (or EMER EXTEN) position, provide hot air anti-icing of the airframe leading edge surfaces and engine forward frame components, and provide electrical anti-icing of the fuel vents and the tip pod rocket doors.

Descent. In making a descent from altitude through icing conditions, select FLIGHT position of anti-icing switch, maintain a minimum of 83% engine rpm and regulate airspeed and rate of descent as in normal descent. If ice then accumulates (additional hot air is required for anti-icing), increase the engine rpm and use speed brakes as necessary to avoid increasing airspeed.

Landing. Switch from FLIGHT to the TAKE-OFF position on or before the final approach of a landing in icing conditions so that maximum thrust will be available if a go-around is required.

CAUTION

The hot air anti-icing systems use air from the engine compressor and thereby reduce the available thrust, increase the specific fuel consumption, and decrease the airspeed. The anti-icing systems should therefore be turned off when icing conditions no longer exist and should not be turned on unless icing conditions are encountered.

ENGINE FUEL FILTER DE-ICING SYSTEM.

A fuel filter de-icing system is provided for the engines. Alcohol can be injected into the system to dissolve ice particles in the fuel filter and in the engine fuel control. On Groups 1 through 70 airplanes, fuel filter icing will be indicated by a warning light on the fuel control panel. On Group 75 airplanes these lights have been omitted, as the primary concern is for de-icing the engine fuel control. Fuel control icing will be evidenced by a drop in rpm, by overspeeding, or lack of throttle response in the affected engine. Overspeeding or drop in rpm in excess of 2% while operating at 100% throttle setting can be construed as an icing condition. Alcohol from a 3.9 US gallon tank, located in the right wing, affords approximately 3 minutes total de-icing time. A 28-volt d-c pump supplies pressure for operation of the fuel filter de-icing system. Two solenoid valves, one for each engine, control the flow of alcohol. Engine fuel icing is not necessarily associated with other icing conditions, but can occur whenever water particles exist in the fuel and temperature of the fuel falls below 0°C (32°F).

Fuel Filter De-Ice Switch and Warning Lights.

A three-position 28-volt d-c switch, spring-loaded to OFF (center) with other positions RH (or RIGHT) and LH (or LEFT) (figure 1-19), is located on the fuel control panel on Groups 1 through 70 airplanes, and on the anti-icing control panel (figure 4-4) on Group 75 airplanes. This switch controls power to a 28-volt d-c motor-driven de-icing pump, and opens either of two normally closed solenoid valves in the lines from the pump to the engine fuel filters. Groups 1 through 70 airplanes have two fuel filter de-ice warning lights (figure 1-19), one for each engine, mounted on the fuel control panel. These lights, controlled by a pressure switch at each filter, will come on when the fuel flow through the filter is restricted by ice formation (or by excessive sediment). When filter icing is indicated (on Groups 1 through 70 airplanes) by either the right or the left light coming on, or when engine fuel control icing is indicated (all airplanes) by variation in engine rpm or lack of throttle response,

the switch should be held to the position representing the affected engine (RH or LH) until the light goes out, or until engine rpm ceases to fluctuate, indicating that the fuel flow is back to normal. Normal flow should resume in 30 seconds or less. When the switch is released, the alcohol pump will stop operating and the solenoid valve in the line to the filter that was de-iced will return to its normally closed position. The alcohol supply will afford 3 minutes or more of the total pump operation as the pump delivery rate averages slightly more than 1 gallon per minute.

Note

If foreign matter, other than ice, restricts the flow of fuel through the filter, the warning light will come on as during icing. A filter clogged by foreign matter will be indicated if the warning light remains on after approximately 30 seconds of de-icing operation. This should not cause alarm, for before the fuel pressure drop across the filter becomes critical, a bypass valve will open and fuel will be routed around the filter. However, it is important to make sure that the filter is cleaned immediately after completion of flight.

RADOME ANTI-ICING SYSTEM (GROUPS 35 AND SUBSEQUENT AIRPLANES).

The radome anti-icing system prevents ice, which would cause radar interference, from forming on the nose of the airplane. Anti-icing fluid is supplied from a pressurized 3.5 US gallon tank to a nozzle, where it is atomized and sprayed over the exterior surface of the radome. The tank is pressurized and the fluid is atomized by air from the 11th stage engine manifold. The compressor air is controlled by a solenoid valve actuated by switches in the pilot's and radar observer's cockpits. To prevent thickening at low temperatures, the fluid is maintained at about 40°F by a thermostatically controlled heater in the tank. For fluid specifications, see figure 1-45.

Radome Anti-Icing Switches.

The system is actuated by placing the pilot's anti-icing switch (figure 4-4), located on the anti-icing control panel, at FLIGHT; however, the radar observer is provided with a 28-volt d-c override switch located on the right side of the cockpit (figure 4-8), which gives him complete control over the system. The switch has three positions: NORMAL, OFF, and EMER. If the override switch is at NORMAL, the pilot's anti-icing switch controls the system. If the override switch is at OFF, the system is off regardless of the position of the pilot's anti-icing switch. If the override switch is at EMER, the system is on regardless of the position of the pilot's anti-icing switch.

Note

The supply of anti-icing fluid will last approximately 1 hour if used continuously. This must be taken into consideration when planning interceptions in icing conditions.

WINDSHIELD HEAT SYSTEM.

The windshield is defrosted and de-iced by two transparent heat-conducting films within the windshield glass. The system operates on alternating current from the 115/200-volt alternator or from the single-phase inverter system, and the temperature is automatically controlled by heat-sensing elements and temperature regulators.

Windshield De-Ice and Defog Knob.

A 28-volt d-c rotary windshield de-ice and defog knob (figure 4-4) on the anti-icing control panel, has OFF, NORMAL, and EMER positions to control the windshield defrost and de-ice circuits. For defrosting, the knob is placed at NORMAL, full a-c power is supplied to the inner heat-conducting film and medium a-c power to the outer heat-conducting film. For de-icing, the knob is placed at EMER, and full a-c power is supplied to both heat-conducting films. The EMER position should be used only for heavy icing conditions, and the knob should be returned to NORMAL as soon as possible. The EMER position should never be used when the airplane is on the ground because the extreme heat applied to the outer film could damage the windshield. Primary power for windshield heat is supplied by the alternator; but if the alternator fails, the single-phase inverter system will supply power for the defrosting circuits.

CAUTION

To prevent possible bubbling of the heat-conducting film in the windshield glass, leave the windshield de-ice and defog knob at NORMAL for at least 1 minute before turning it to EMER. Only in heavy icing conditions should it be turned to EMER. Never operate the system on EMER longer than necessary.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT.**INTERPHONE SYSTEM.**

The interphone system, operating on 28-volt dc, provides the following facilities: speech communication within the airplane with or without the use of microphone switches; communication beyond the airplane by integration with its radio equipment; monitoring

of received signals either individually or simultaneously; and a call facility which permits transmission of urgent communication to both headsets regardless of individual control panel switch settings. Receptacles in the right wheel well and in the aft radio and equipment section allow communication between the airplane crew and the ground crew. On Groups 1 through 25 airplanes, the AN/AIC-2 system is installed; on Group 30 and subsequent airplanes, the AN/AIC-10 system is installed.

Interphone Control Panel AN/AIC-2 (Groups 1 Through 25 Airplanes).

The interphone control panel (figure 4-9) is on the right console in each cockpit. Each panel has a volume control knob, a filter switch, four toggle switches (which enable the operator to receive or cut out incoming signals from interphone, command, marker beacon, or localizer receivers), and a rotary selector switch to connect the microphone to the transmission equipment. When the selector switch is at MIX, SIG. & COMMAND, the interphone remains on so that the pilot and radar observer can talk to each other without pressing a microphone button and either crewmember can transmit on the command radio without changing the position of the interphone selector switch. When this switch is at either COMMAND or INTER the "hot mike" feature is switched out and only the facility selected may be used, with normal use of microphone for transmission. The selector switch set at COMPASS with the compass toggle switch at ON enables the operator to receive signals through the radio compass receiver without interference from transmission. When the selector switch is held to CALL, all other signals are cut out and the interphone communication will be heard in each headset regardless of other interphone switch positions.

Interphone Control Panel AN/AIC-10 (Group 30 and Subsequent Airplanes).

An interphone control panel (figure 4-9) is located on the right console in each cockpit. Each panel has a volume control knob, five (toggle) mixing switches, a rotary selector switch, and an auxiliary listen switch. The mixing switches marked INTER, COMM, MARKER, ADF, and VHF NAV enable the operator to monitor incoming signals from all five sources (interphone, command, marker beacon, radio compass, or omnirange and localizer) or to select any combination. The rotary selector switch has positions COMM, COMM-INTER, INTER, and CALL. The switch's function is conventional. For example, with the switch at COMM-INTER or CALL, the microphone is open for interphone communication, but with the switch at either COMM or INTER, the operator must press a microphone button to talk or transmit. The auxiliary listen switch has NORMAL and AUX LISTEN positions. The toggle is safetied at NORMAL (up). When the switch is moved to AUX LISTEN any incoming

COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT

TYPE	DESIGNATION	FUNCTION	OPERATOR	RANGE	LOCATION OF CONTROLS
INTERPHONE	AN/AIC-2 OR AN/AIC-10	CREW INTERCOMMUNICATION	PILOT OR RO	COCKPIT	PILOT'S AND RO'S RIGHT CONSOLES
UHF COMMAND	AN/ARC-27	AIR-TO-AIR AND AIR-TO- GROUND COMMUNICATION	PILOT OR RO	LINE-OF-SIGHT	PILOT'S AND RO'S RIGHT CONSOLES
RADIO COMPASS	AN/ARN-6	VOICE RECEPTION, RADIO NAVIGATION	PILOT OR RO	150 MILES — AVERAGE CONDITIONS	PILOT'S AND RO'S RIGHT CONSOLES
VHF NAVIGATION	AN/ARN-14	VOR, VAR NAVIGATION, VOICE RECEPTION, LOCALIZER	PILOT	LINE-OF-SIGHT	PILOT'S INSTRUMENT PANEL AND RIGHT CONSOLE
GLIDE-PATH	AN/ARN-18	INSTRUMENT APPROACH GLIDE-PATH	PILOT	15 MILES	PILOT'S RIGHT CONSOLE
MARKER BEACON	AN/ARN-12	RECEPTION OF MARKER BEACON SIGNALS ON RANGE AND LOCALIZER LEGS	PILOT	FROM GROUND TRANSMITTER TO AIRPLANE	PILOT'S INSTRUMENT PANEL
FLIGHT COMPUTER	A-1 OR A-2	APPROACHING AND HOLDING PRE-SELECTED COURSE AND ALTITUDE	PILOT	LINE-OF-SIGHT	PILOT'S INSTRUMENT PANEL
IFF	AN/APX-6 OR AN/APX-6 A	AUTOMATIC AIRCRAFT IDENTIFICATION	PILOT	LINE-OF-SIGHT	PILOT'S RIGHT CONSOLE

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Figure 4-5.

RADAR OBSERVER'S COCKPIT-FRONT VIEW

(Typical)

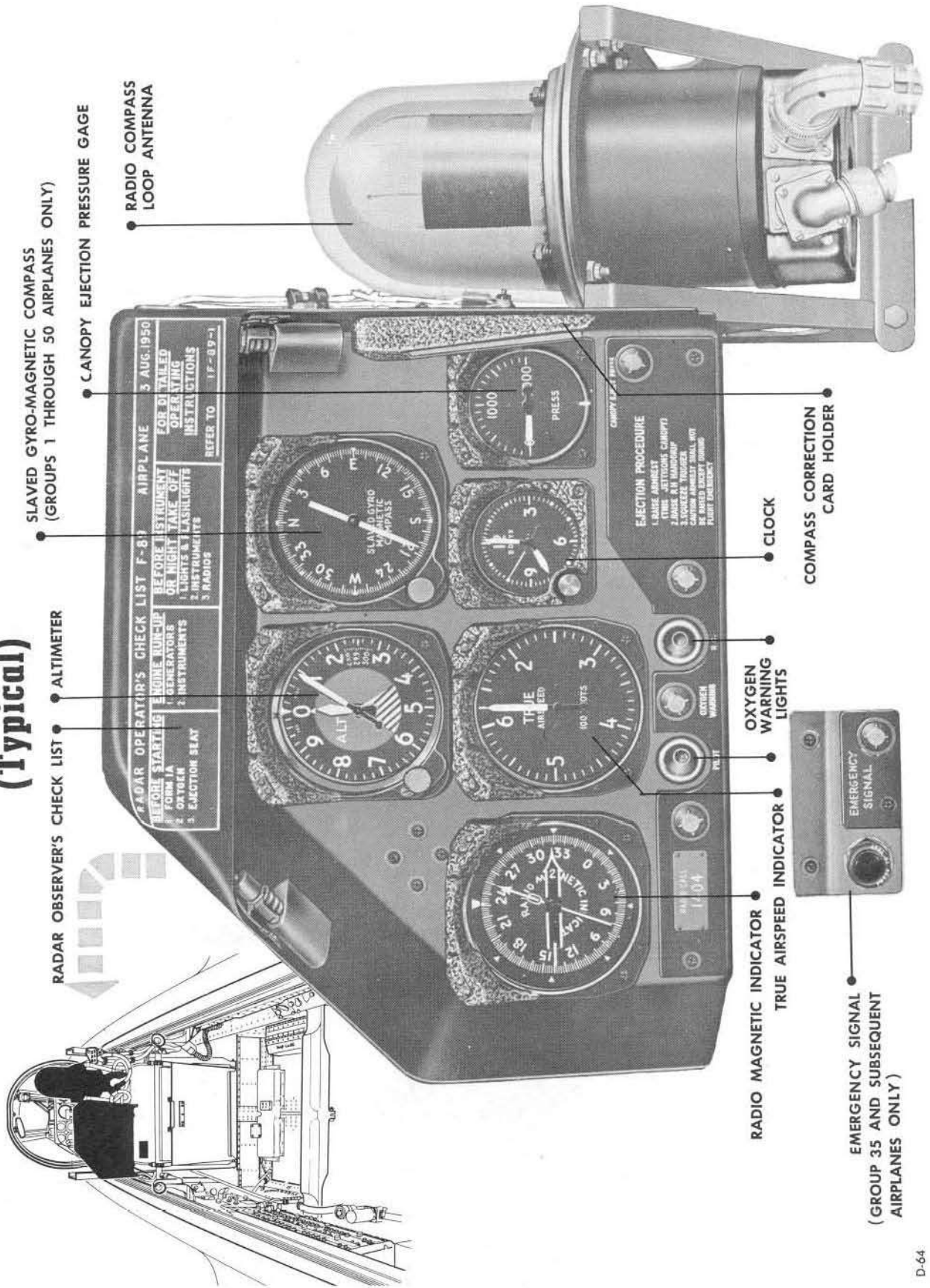


Figure 4-6.

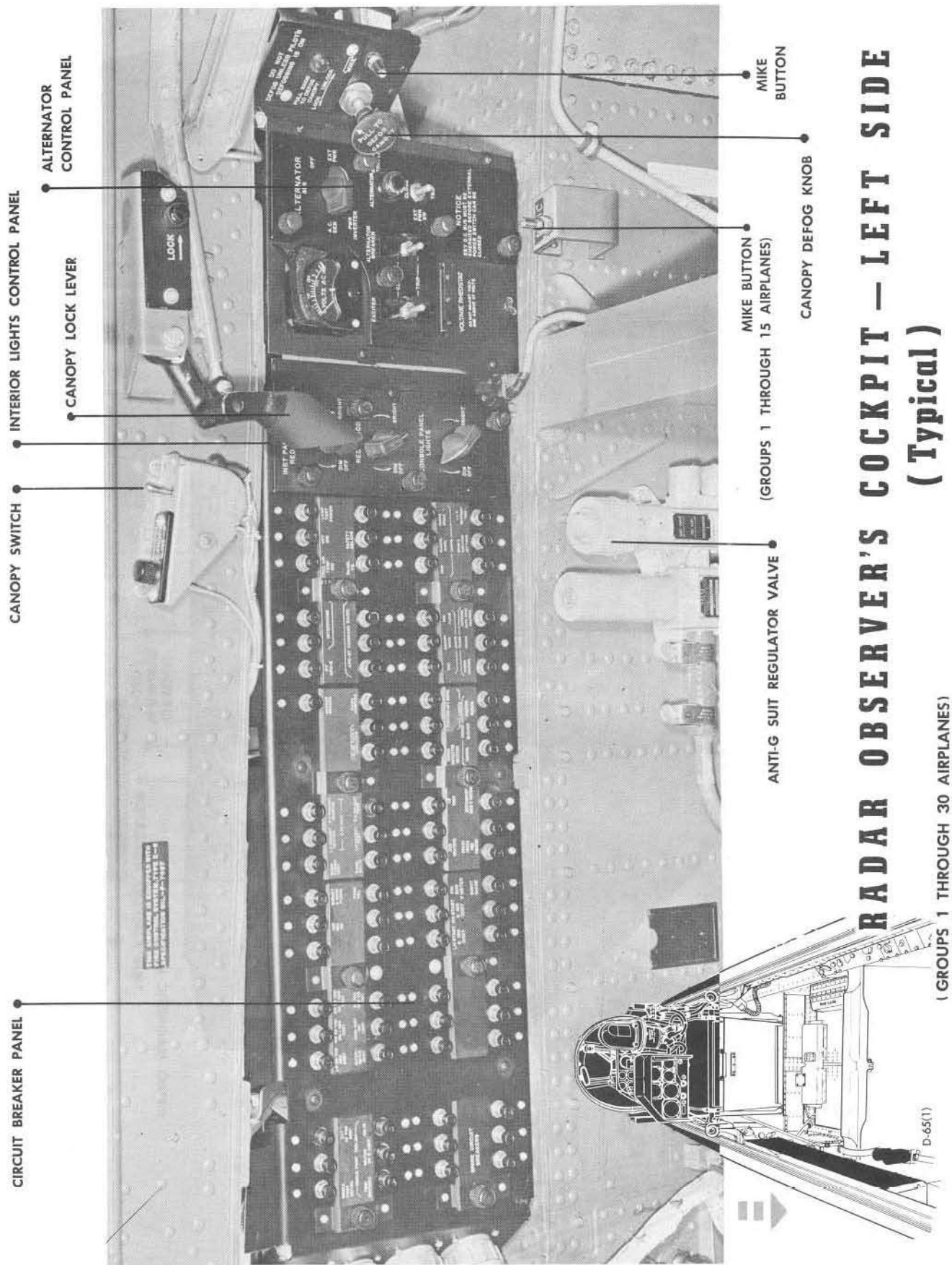


Figure 4-7 (Sheet 1 of 2 Sheets).

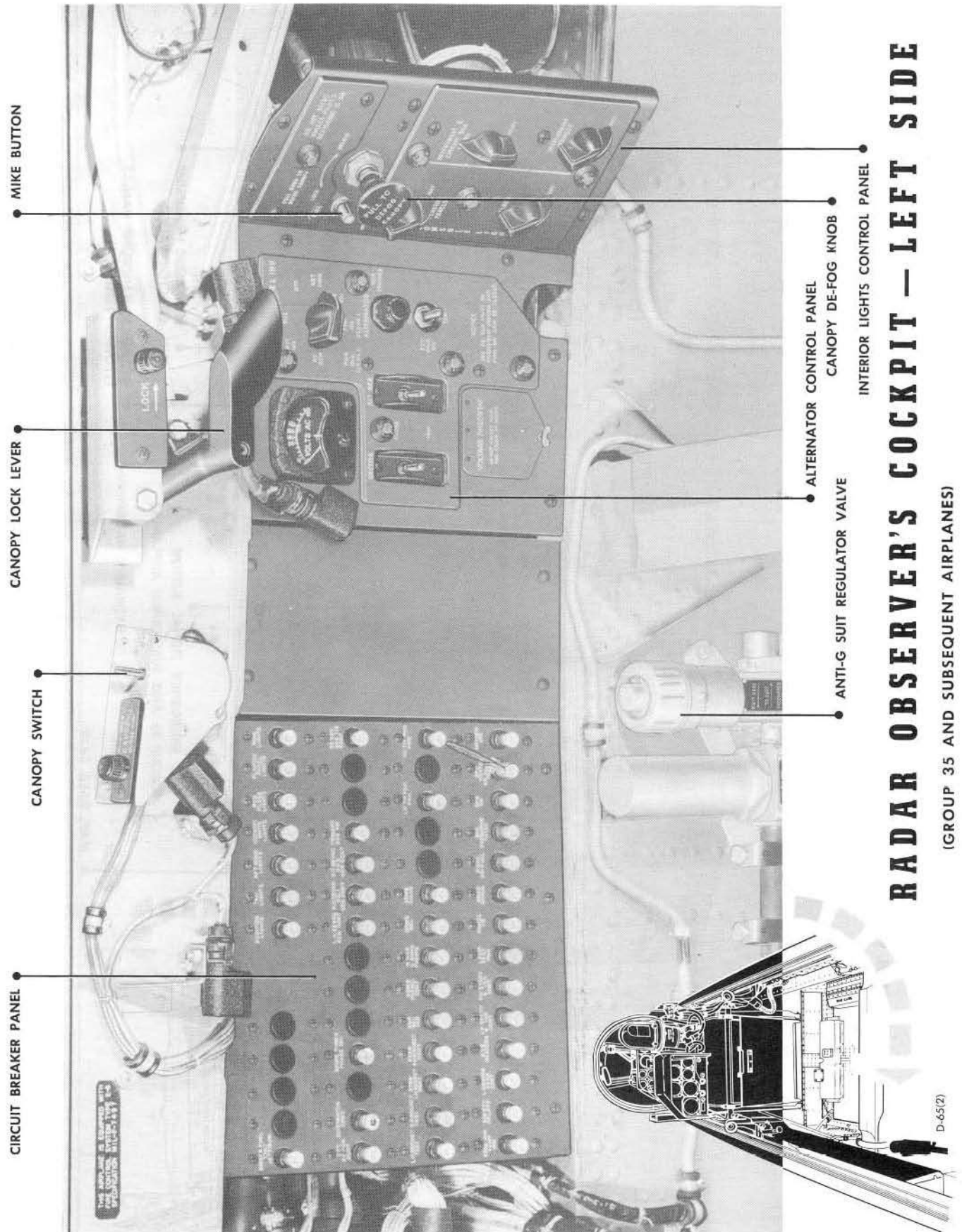
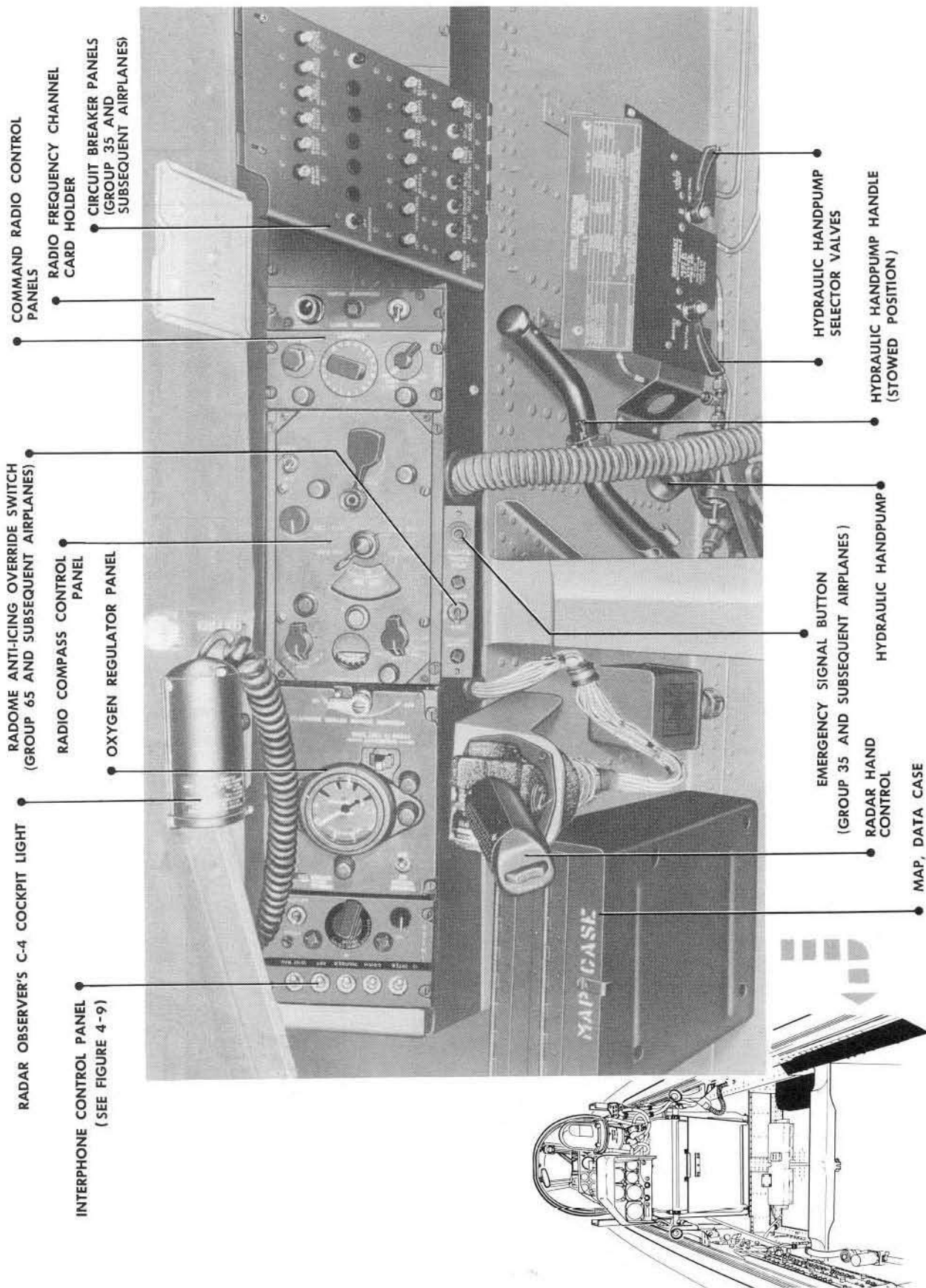


Figure 4-7 (Sheet 2 of 2 Sheets).



RADAR OBSERVER'S COCKPIT — RIGHT SIDE (Typical)

D-66

Figure 4-8.



Figure 4-9.

signals bypass the interphone amplifier and come into the headset at line level (unamplified).

ADF Filter Switch (Group 30 and Subsequent Airplanes).

The ADF filter switch panel (figure 1-15) is located on the pilot's right console. The filter switch is conventional in function and has VOICE, RANGE, and BOTH positions to mix or filter voice and range signals when the radio compass is receiving on loop or antenna.

Pilot's Microphone Switches.

A pilot's microphone switch (figure 1-7), located on the throttle for the right engine, and on some airplanes an alternate microphone switch (figure 1-30), located on the control stick grip, can be pressed to transfer the microphone input from the interphone to the command transmitter.

Radar Observer's Microphone Switches.

A radar observer's microphone switch (figure 4-7) is located adjacent to the canopy defog knob and, when pressed, transfers the microphone input from the interphone to the command transmitter. A foot-operated switch, located on the floor under the radar scope, serves as a radio audio disconnect switch. When pressed, it prevents all incoming radio signals from reaching both the front and rear cockpits; however, the radar observer can talk to the pilot on the interphone. This arrangement permits the radar observer to shut out temporarily any distracting radio noises while concentrating on the radar scope.

Interphone Operation (Groups 1 through 25 Airplanes).

1. Filter switch—NORMAL USE.
2. Interphone selector switch—MIX. SIG. & COMMAND.
3. Interphone toggle switch—INTER.
4. Volume control knob—Adjust as desired.

Note

The interphone set is in operation whenever electrical power is on the airplane, unless the interphone circuit breakers (on the radar observer's circuit breaker panel) are pulled out.

Interphone Operation (Group 30 and Subsequent Airplanes).

1. Filter switch—BOTH.
2. Interphone selector switch—COMM-INTER.
3. Interphone toggle switch—INTER.
4. Auxiliary listen switch—NORMAL.
5. Volume control knob—Adjust as desired.

Note

The interphone set is in operation whenever electrical power is on the airplane, unless the interphone circuit breakers (on the radar observer's circuit breaker panel) are pulled out.

COMMAND RADIO AN/ARC-27.

The command radio set, operating on 28-volt dc, is used for airplane-to-airplane and airplane-to-ground communication. The range varies with altitude and atmospheric conditions. A UHF channel identification holder is beneath the right cockpit rail on Groups 1 and 5 airplanes, and on the forward right sliding canopy frame directly below the defog duct on Group 10 and subsequent airplanes.

Note

No transmission will be made on emergency (distress) frequency channels except for emergency purposes. For test, demonstration, or drill purposes, the radio will be operated in a shielded room to prevent transmission of messages that could be construed as actual emergency messages.

Command Radio Controls.

Control panels (figure 4-10) for the command radio are on the pilot's and radar observer's right consoles. Each control panel has a power control switch, channel selector switch, volume control knob, control-shift switch, and a green indicator light. The control-shift switches transfer control of the command radio to either cockpit, and the green light comes on in the cockpit having control. To transmit to the ground or to another airplane, a microphone switch must be depressed.

Command Radio Operation.

1. Power control switch—T/R. Allow equipment to warm up for at least 1 minute.

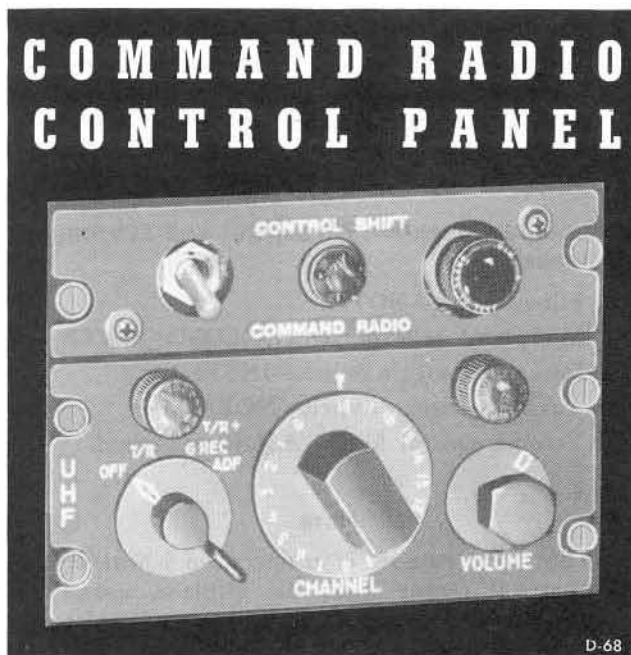


Figure 4-10.

2. Channel selector switch—Rotate to desired frequency channel. Set is now ready to transmit and receive.

3. Power control switch—T/R G REC, if simultaneous reception on guard-frequency channel and another channel is desired.

4. Volume control knob—Adjust as desired.

5. Microphone button—Press to transmit.

6. Power control switch—OFF to turn set off.

CAUTION

- When the command radio set has been turned off, do not turn set on again for 1 minute. Allowing the condensers to discharge prevents excessive power surge.
- To avoid damage to the selector mechanism, do not select another channel while set is in midcycle.

RADIO COMPASS AN/ARN-6.

The radio compass, operating on 28-volt d-c power, indicates the direction to any selected transmitting station when the radio compass is set for homing operation of the loop antenna. The signal of this receiver is fed to the No. 1 needle of each radio magnetic indicator on the pilot's and radar observer's instrument panels.

Radio Compass Controls.

Radio compass control panels (figure 4-11) are on the right console of each cockpit. Each control panel has a function switch, frequency band selector switch, loop L-R switch, volume control knob, CW-voice switch, and tuning crank. Either crewmember can gain control of the radio compass by turning the function switch to CONT.

Radio Compass Operation.

1. Function switch—CONT momentarily to gain control; then turn to desired position. Allow at least 5 minutes for warmup.
2. Interphone selector switch—Any position.
3. Interphone radio compass switch—ADF.
4. Frequency band selector switch—Turn to desired frequency.
5. Volume control knob—Adjust.
6. Function switch—OFF, to turn set off.

Note

Operation of the E-6 fire control system will result in complete malfunction of the AN/ARN-6 radio compass around 400 kc.



Figure 4-11.

VHF NAVIGATION SET AN/ARN-14.

This equipment receives visual omnirange, visual-aural range, localizer, and communications signals in the high-frequency range of 108.0 to 135.9 megacycles. It employs 280 channels spaced 100 kilocycles apart, in the following categories:

FREQUENCY ALLOCATIONS

<i>Frequency Band in Megacycles</i>	<i>Type of Service</i>
108.0—111.9	Runway Localizer
108.3—110.3	Visual-Aural Range (VAR)
111.0—111.9	Weather Broadcasts

*Frequency Band
in Megacycles*

112.0—117.9
118.0—121.9
122.0—135.9

Type of Service

Visual Omnirange (VOR)
Tower
General Communications

As the transmission in these bands is line-of-sight, reception varies from 3 miles unobstructed distance at sea level, to approximately 100 miles at 10,000 feet, and even greater distances at higher altitudes. The dynamotor operates on 28-volt dc; the indicators operate on 26-volt ac from the C-4 amplifier. For instructions covering use of this equipment for autopilot-controlled approach, see Automatic Approach Equipment (Group 35 and subsequent airplanes), this section.

VHF Navigation Set Controls.

The VHF navigation control panel (figure 4-12) on the pilot's right console has a power switch, a frequency selector knob, and a volume control knob. The power switch is turned from OFF to POWER ON to put the set into operation. The inner and outer rings of the frequency selector dial rotate to show, as a whole number, megacycles from 108 to 135 in the top three windows of the frequency selector dial. A center knob tunes in intervals of hundred-kilocycles which appear as decimal parts of a megacycle in the bottom window of the dial.

VHF Navigation Set Indicators.

Two indicators for this equipment are on the pilot's instrument panel. A course indicator registers VOR, VAR, localizer, and glide-slope orientation. A radio magnetic indicator combines the functions of a directional indicator repeater with those of a dual radio



Figure 4-12.

compass. A duplicate radio magnetic indicator is on the radar observer's instrument panel.

Radio Magnetic Indicator. The radio magnetic indicator (figure 4-13) includes a rotating compass card and two needles. The rotating card is coupled to the directional indicator. The signals of the radio compass are fed to the No. 1 needle; the signals of the omnirange receiver are fed to the No. 2 needle when the receiver is tuned to a VOR transmitter. The angle between the needle and the index at the top of the instrument face will give the relative bearing; and the radio magnetic indicator will read, on the card under the point of the needle, the actual magnetic bearing to the station regardless of the heading of the airplane. Since the card will hold to magnetic north and the two needles will hold to the tuned radio stations, the card and the needles will appear to rotate as if fixed together whenever a tight turn is made at some distance from the stations.

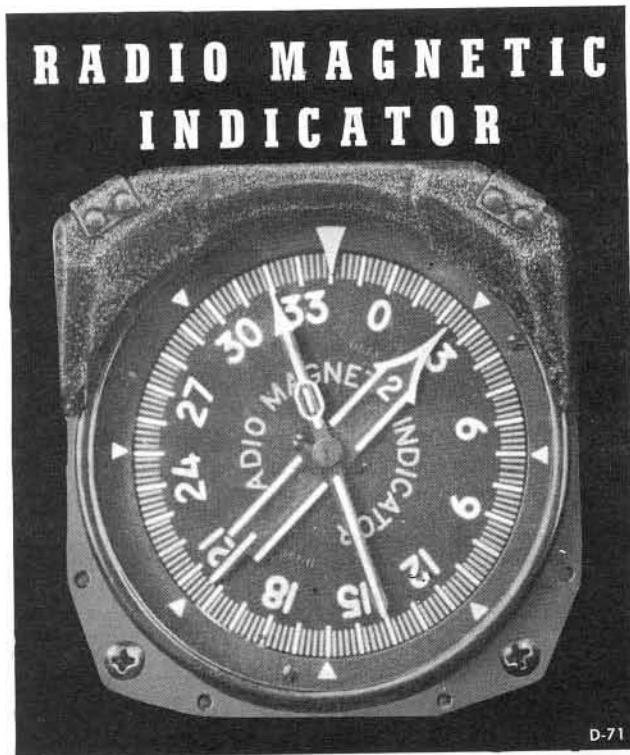


Figure 4-13.

Course Indicator. The course indicator (figure 4-14) has a marker-beacon indicator light in one corner and a course set knob in the opposite corner. On the face of the instrument are a course window, which displays the number of the omnirange radial set up by the knob; a sensing window, which indicates whether the radial course leads to or from the omnirange station; a relative heading needle, which is coupled to the directional indicator; a vertical sliding bar; and a

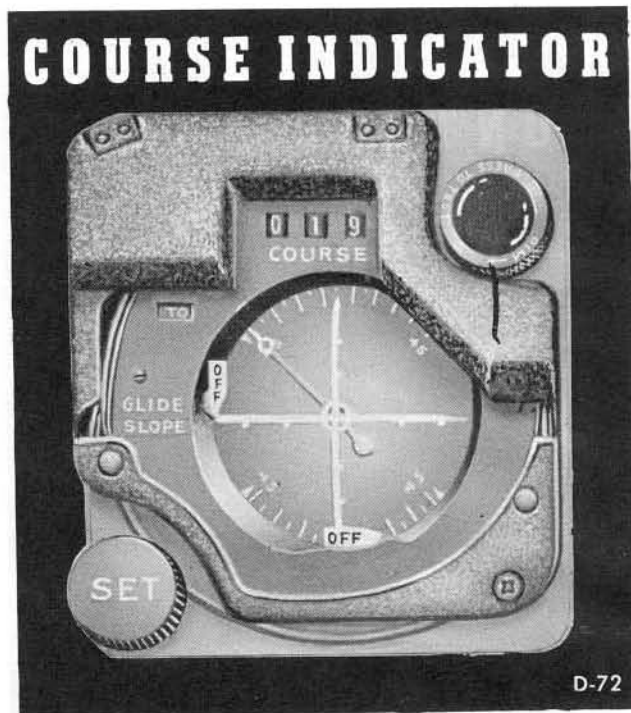


Figure 4-14.

horizontal sliding bar. When the receiver is tuned to a VOR station and the warning "Off" flags have retracted from the face of the instrument, the instrument shows which of the 360 radials of the omnirange station has been selected (course window), whether that radial course leads to or from the station (sensing window), whether the radial lies right or left of the airplane (vertical bar indication), and whether the airplane is headed right or left of the selected course (relative heading needle). The horizontal bar does not respond to VOR signals; but when a glide-slope transmitter has been tuned in, the bar will show the position of the airplane with respect to the glide-slope.

VHF Navigation Set Ground Check.

1. Single-phase inverter switch—MAIN (NORMAL).
2. Three-phase inverter switch—MAIN.
3. Directional indicator slave switch—IN.
4. Interphone selector switch—Any position.
5. Interphone radio compass switch—ADF.
6. Interphone localizer switch—VHF-NAV.
7. VHF power switch—POWER ON.
8. VHF frequency selector knob—Set on frequency of nearest omnirange station.
9. Radio compass function switch—CONT. When reaction of meter indicates that control has been obtained, turn to COMP.

10. Course indicator—Check that warning "Off" flag has retracted from vertical bar after equipment has had a 2- to 5-minute warmup.

11. Radio magnetic indicator—Note that compass card reads the airplane heading and that one needle swings to bearing of omnirange station.

12. Course set knob—Rotate to set bearing to VOR station in course window. Note that vertical bar centers, and that sensing window reads TO. Note that relative heading needle is displaced to the same side of the station as the airplane's heading. Rotate course set knob to set up radials 7 degrees to right and 7 degrees to left, and note that vertical bar moves promptly and smoothly to full deflection on appropriate side. Continue rotating course set knob. When difference exceeds 90 degrees, note that the vertical bar crosses to the opposite side of instrument, and sensing window shows FROM. When reciprocal radial is reached, note that vertical bar comes to center.

13. VHF frequency selector knob—Tune to nearest VAR or localizer transmitter, if one is within receiving distance, and note that vertical bar makes correct response.

14. Radio compass frequency band selector switch—Tune to nearest suitable transmitter and note that second needle of radio magnetic indicator swings to proper bearing.

15. VHF power switch—OFF, to shut down receiver.

16. Radio compass function switch—OFF, to turn set off.

VHF Navigation Set Operation.

1. VHF power switch—POWER ON.
2. VHF frequency selector knob—Rotate inner and outer ring of dial to select frequency.
3. VHF volume control knob—Adjust as desired.
4. VHF power switch—OFF, to turn set off.

VHF Navigation Set—Operation with VOR.

1. VHF power switch—POWER ON.
2. VHF frequency selector knob—Set for desired VOR station. Allow 2 minutes for warning "Off" flag to retract from vertical bar.
3. Course set knob—Rotate to center vertical bar. Read radial in course window and identify it as course to or from the station as indicated in sensing window. Read relative heading needle to determine whether aircraft is headed right or left of course. If reciprocal is desired, rotate course set knob to add or subtract 180 degrees; read course and sensing as now indicated. To fly on a radial other than the one the airplane is on, set up desired radial in course window. Vertical bar will then be deflected toward new radial. Fly toward vertical bar to arrive at desired radial, then turn onto course as bar centers. Adjust heading as necessary to compensate for drift. As long as vertical bar is

centered, airplane is tracking along displayed radial, regardless of heading. Relative heading needle will indicate drift angle. When airplane crosses station while tracking along displayed radial, sensing will reverse with no changes in other indications of the instrument. When airplane is not tracking along displayed radial, vertical bar will be off center. In such a case, bar will swing to opposite side when airplane crosses displayed radial. To turn smoothly onto radial, steer to hold point of relative heading needle on vertical bar until both are centered. Sensing will reverse when airplane crosses the radial that is at 90 degrees to displayed radial.

VHF Navigation Set—Operation With VAR.

1. VHF power switch—POWER ON.
2. VHF frequency selector knob—Set to desired VAR station. Allow 2 minutes for warning "Off" flag to retract from vertical bar.
3. Note deflection of vertical bar. If bar deflects to left, airplane is in blue sector of range; if bar is to right, airplane is in yellow sector. Consult airways chart to identify sector.

Note

On VAR, the deflection of the vertical bar does not in itself indicate the direction in which to fly to get on course. It indicates merely the color sector in which the airplane is flying.

4. Identify signal in headphones as aural N or A, and consult airways chart to determine whether station is ahead or astern. If aural signals overlap to give a continuous dash, airplane is on aural leg at right angles to visual range.

5. Relative heading needle indicates heading relative to course selected.

WARNING

Blue and yellow sectors are assigned to opposite sides of the visual range in accordance with the course defined by the airway. At certain terminal airports, VAR is used in the absence of a localizer. In such cases, the sector orientation is the same as for an ILS localizer. That is, the blue sector is charted on the right and the yellow sector is charted on the left when the airplane is inbound on final approach, regardless of the course defined by the beam.

VHF Navigation Set—Operation with Localizer.

1. VHF power switch—POWER ON.
2. VHF frequency selector knob—Set to localizer

station. Allow 2 minutes for warning "Off" flag to retract from vertical bar.

3. Note deflection of vertical bar. If vertical bar is deflected to left, airplane is in blue sector of localizer range; if bar is to right, airplane is in yellow sector. Blue sector of a localizer is always charted to the right of the inbound course; therefore, a pilot on final approach can center on the beam by flying toward the bar.

4. Relative heading needle indicates required correction angle.

VHF Navigation Set—Operation for Communications.

The receiver can be tuned to the appropriate transmitter to receive weather broadcasts, tower instructions, and general communications.

GLIDE-SLOPE RECEIVER AN/ARN-18.

The glide-slope gives vertical guidance to a pilot making an instrument approach to an airport equipped with a glide-slope transmitter. The receiver has no separate control panel. It is operated and tuned by the power switch and the frequency selector knob on the VHF navigation control panel (figure 4-12), and its signals are fed automatically to the horizontal bar of the course indicator. When the set is tuned to a glide-slope transmitter and the signal is strong enough to retract the warning "Off" flag from the horizontal bar, the pilot merely keeps the horizontal bar centered to follow the glide-slope down to the runway. In brief, centering the two crossbars of the course indicator keeps the airplane on course and on glide-slope for an instrument approach under adverse weather conditions. The set is powered by the single-phase inverter system.

MARKER BEACON RECEIVING SET AN/ARN-12.

The marker beacon receiving set gives visual and aural coded signals whenever the airplane passes over a marker beacon transmitter, thus enabling the pilot to determine his exact position. The visual signal is given by an amber light (figure 4-14) on the pilot's course indicator, the aural signal through the interphone system whenever the interphone marker beacon switch is ON. The set operates whenever the 28-volt d-c bus is energized.

A-1 FLIGHT COMPUTER (GROUPS 1, 5, AND 10 AIRPLANES).

The A-1 flight computer electronically combines attitude, altitude, direction, and radio information on a single instrument. The flight computer may be used in flying a constant-altitude compass course, in making ground-controlled approaches, instrument low approaches, and go-arounds. The A-1 flight computer has a selector switch, altitude control and go-around switch (figure 4-15), and a flight computer indicator (figure 4-16) on the pilot's instrument panel. The system is

energized whenever the airplane's electrical power is on and the main or spare three-phase inverter is operating. If the main and spare three-phase inverters fail, the heading pointer on the flight computer will continue to operate; however, the horizontal and vertical bars will be inoperative.

A-2 FLIGHT COMPUTER (GROUP 15 AND SUBSEQUENT AIRPLANES).

The A-2 flight computer electronically combines attitude, altitude, direction, and radio information on a single instrument. The flight computer may be used for flying a constant altitude compass course, for making ground-controlled approaches, for making instrument low approaches, and for go-arounds. Except for the addition of a radio rate unit, and a go-around feature (controlled by pressing the altitude control switch), the A-2 flight computer is similar to the A-1 flight computer. The radio rate unit feeds into the computer a signal derived from the rate of change of the localizer signal as the airplane nears the runway, so that the pilot, by keeping the vertical bar centered, can fly the localizer beam heading without correcting for wind drift on the heading indicator. This feature reduces the likelihood of overcorrecting for wind drift during the latter stages of a low approach. The flight computer has a selector switch (figure 4-15) and a flight computer indicator (figure 4-16) on the pilot's instrument panel. The system receives its a-c power

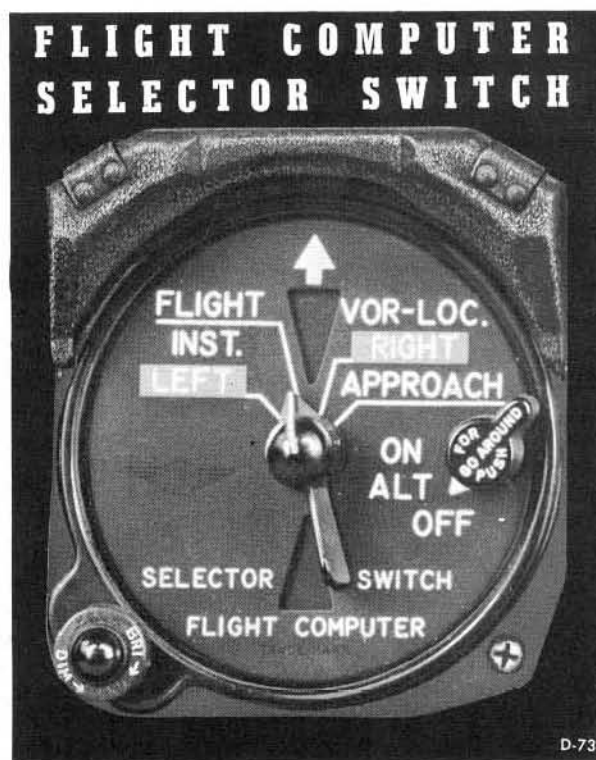


Figure 4-15.

from either the main or spare three-phase inverter on Groups 15 through 30 airplanes, and on Group 35 and subsequent airplanes, from the 2500-na single-phase inverter (through a phase converter) or if the 2500-na inverter fails, from either the main or spare three-phase inverters. If the source of a-c power fails, the directional indicator on the flight computer will continue to operate; however, the horizontal and vertical bars will be inoperative.

Flight Computer Indicator.

The flight computer indicator (figure 4-16), centered at the top of the pilot's instrument panel, has a course dial, a heading pointer, and two crossbars. A course set knob is on the lower left corner of the case and a pitch-trim knob on the lower right corner. Turning the course set knob rotates the course dial to bring the desired track figure under the course index at the top of the instrument face. The heading pointer is coupled to the gyrosyn compass so that the magnetic heading of the airplane can be read continuously on the course dial under the heading pointer. The vertical bar deflects to give an appropriate "fly right" or "fly left" indication. When the pilot turns the airplane to zero the vertical bar, the heading pointer follows the heading of the airplane as it turns onto the new course. The vertical bar will not go past zero unless the airplane is overcontrolled in making the correction. When the airplane is on the selected course, the heading pointer and the vertical bars are centrally aligned with the course index. Deviations in pitch, altitude, and glide-slope signals cause the horizontal bar to move up or down. The pitch-trim knob in the lower right corner adjusts the horizontal bar to compensate for changes in airplane pitch trim during flight. Clockwise rotation of the pitch-trim knob causes the horizontal bar to give a "fly up" indication.

Flight Computer Selector Switches.

The flight computer selector switch (figure 4-15) on the pilot's instrument panel has positions LEFT, FLIGHT INST, VOR-LOC RIGHT, and APPROACH. When the selector switch is at FLIGHT INST, the flight computer indicator is used as a flight instrument independent of radio signals. When the selector switch is at any other position, radio signals are relayed into the flight indicator for localizer, approach, and landing purposes. When the selector switch is on any position but APPROACH and the airplane is flying at the desired flight altitude, an altitude control switch on the right side of the selector switch can be turned to ON. Altitude control signals will then be sent into the flight indicator and any deviation in altitude will cause the horizontal bar to move off zero. When the altitude control switch is turned to ON, the pitch-trim knob on the flight indicator becomes inoperative and the green light in the lower left corner of the selector switch goes out. When the selector

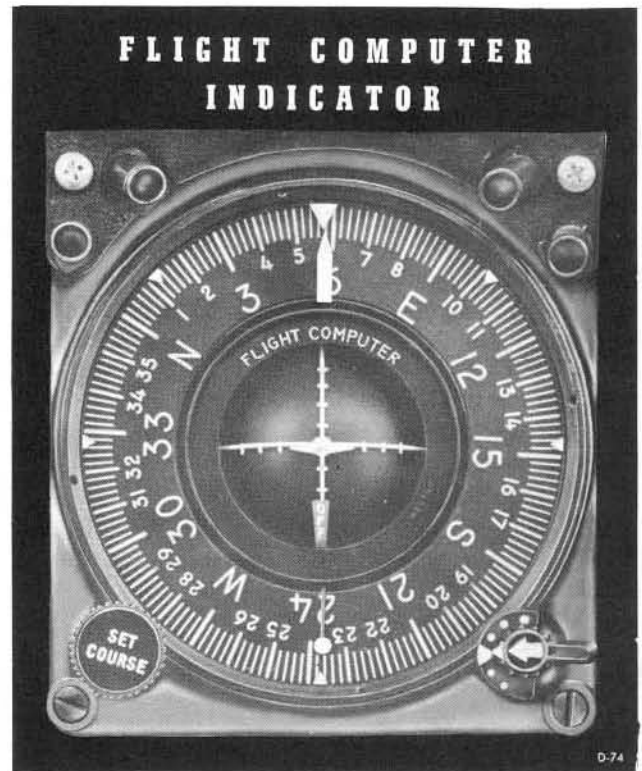


Figure 4-16.

switch is turned to APPROACH, the green light comes on to indicate that the altitude control has turned off automatically to prevent conflicting signals from going into the flight computer. When the selector switch is at APPROACH and a go-around is necessary, the pilot can press the altitude control switch and the horizontal bar will move to indicate the optimum climbout angle.

Starting and Ground Check.

1. Three-phase inverter switch — MAIN (NORMAL).
2. Directional indicator slave switch—IN.
3. Flight computer selector switch—FLIGHT INST.
4. Course set knob—Turn to make course dial read the heading shown by the directional indicator. When the flag disappears, indicating that the quick erector has completed its cycle, the vertical crossbar should be approximately at zero and the directional indicator should be aligned with the index.
5. Altitude control switch — ON. Horizontal bar should not move more than one needle width, if at all. Green light should be off when altitude control switch is ON.
6. Course set knob—Turn to rotate card to the right and then to the left; the vertical bar should signal "fly left" and "fly right" respectively. Turn course

set knob to make course dial read the heading of the directional indicator. Vertical bar should zero and directional indicator should realign with the index.

7. Pitch-trim knob—Turn clockwise and counter-clockwise. Horizontal bar should move up and down respectively.

8. VHF power switch—POWER ON.

9. VHF frequency selector knob—Turn for proper channel.

10. Flight computer selector switch—APPROACH. Vertical bar on the flight computer indicator should move to left or right, depending on position of airplane relative to the beam.

11. Altitude control switch—Push in to energize go-around circuit. Horizontal bar should indicate "fly-up" and the orange flag should appear.

12. Flight computer selector switch—VOR-LOC RIGHT. Orange flag and "fly-up" indication should disappear.

13. VHF power switch—OFF.

Flying Compass Course at Constant Altitude.

1. Selector switch—FLIGHT INST.

2. Course set knob—Rotate to bring desired track figure on course dial under the course index. Vertical bar will move to right or left.

3. Vertical bar—Note deflection and fly to rezero and to align directional indicator with course index.

4. Pitch-trim knob—Turn to zero horizontal bar at desired airplane pitch attitude.

5. Altitude control switch—ON when airplane reaches desired altitude. Green light on the selector switch should go out.

CAUTION

Whenever sudden altitude changes in excess of 500 feet are anticipated, the altitude control switch should be turned OFF to prevent damage to the altitude control unit.

6. Fly airplane to keep horizontal and vertical bars zeroed at all times.

Note

When airplane configuration is changed, turn the altitude control switch to OFF until the new configuration is established.

IFF AN/APX-6 OR -6A.

Groups 1 through 60 airplanes are equipped with AN/APX-6 IFF. Group 65 and subsequent airplanes are equipped with AN/APX-6A. The purpose of the

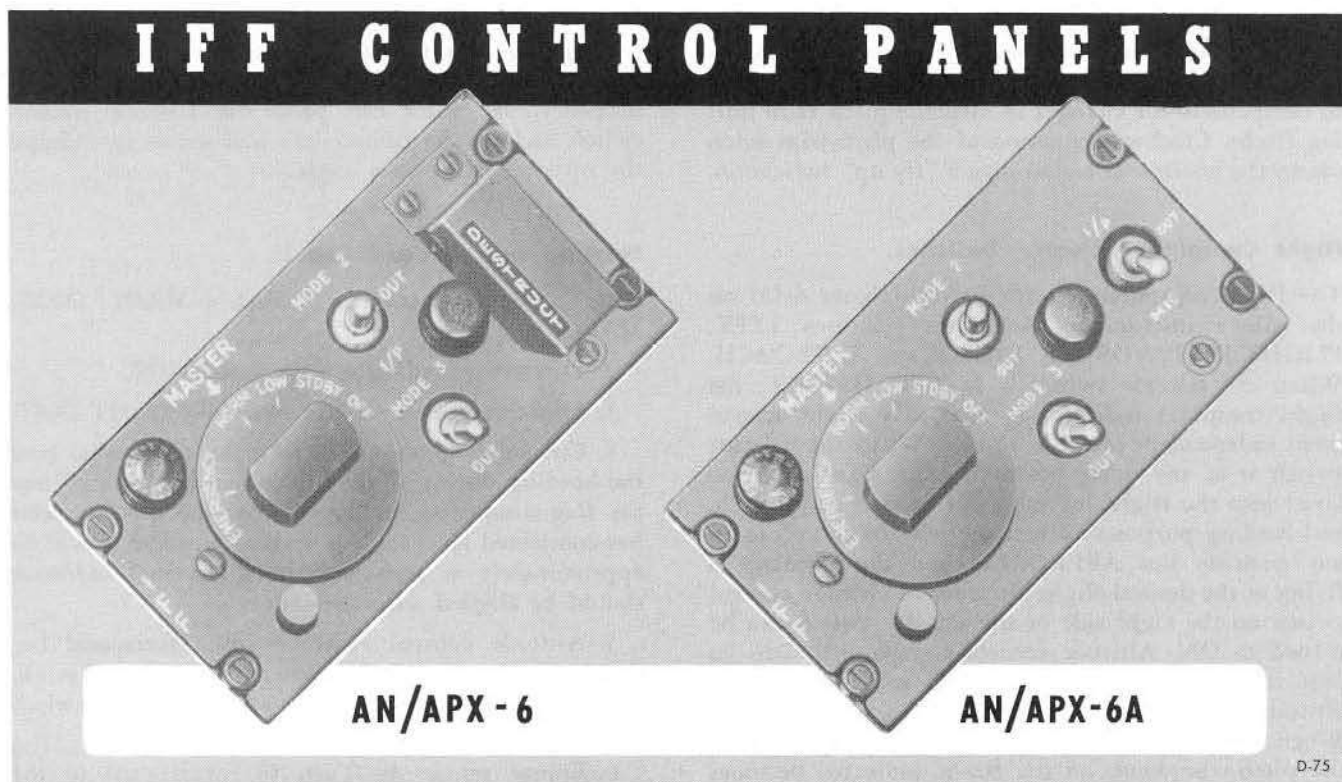


Figure 4-17.

IFF equipment is to identify as friendly the airplane in which it is installed when challenged by an interrogator-responder associated with friendly radars. When a radar target is accompanied by a proper IFF reply, that target is considered friendly. This system operates on 28-volt dc from the primary bus, and 115-volt ac from the auxiliary a-c bus. The destruction unit found in the APX-6 (Groups 1 through 25 airplanes) is powered by 28-volt dc from the battery bus.

IFF Controls.

The master control knob, mode selector switches, and destructor switch (on the APX-6) are on the IFF control panel (figure 4-17) located on the pilot's right console.

IFF Normal Operation.

Turn on the IFF equipment by placing the master control knob at STBY. The tactical situation or the communications officer will determine the ultimate position of the master control knob and mode switches for each mission. To turn the equipment off, place the master control knob at OFF.

IFF Emergency Operation.

For emergency operation, press dial stop and turn the master control knob to EMERGENCY. On airplanes in compliance with T.O. 1F-89-604 a switch is added to each ejection seat, to provide automatic selection of IFF emergency mode whenever either seat is ejected from the airplane.

IFF Destruction.

Only the APX-6 sets are equipped with destructors. To fire destructors, lift the guard labeled DESTRUCT with enough force to break the safety wire; then push the switch forward to ON. Groups 1 through 30 airplanes are equipped with an impact switch that automatically fires the IFF destructor unit in case of a crash.

WARNING

The destructor control should be operated only when the IFF is in danger of falling into enemy hands. If fired inadvertently, report it immediately so that a new receiver-transmitter may be installed.

LIGHTING EQUIPMENT.

EXTERIOR LIGHTING.

Position Lights and Control Switches.

The position lights are conventional in color and arrangement and operate on 28-volt dc. The position

lights switch (figure 4-18) on the pilot's aft miscellaneous control panel has STEADY, OFF, and FLASH positions for controlling the operation of the lights. A switch to the left of the position lights switch has DIM or BRIGHT positions to determine the intensity of the position lights. A flasher unit flashes the position lights at 40 cycles per minute; if the flasher unit fails, steady operation of the lights is automatic. The circuit breaker for the position lights is on the radar observer's circuit breaker panel.



Figure 4-18.

Landing Light and Control Switches.

On airplanes not equipped with the nose wheel steering system, a landing light extension switch (figure 4-19), located on the pilot's left vertical console, controls the extension-retraction motor. Extension or retraction requires approximately 8 seconds, during which time the light can be stopped at any point along the 90-degree arc by moving the switch from EXTEND or RETRACT to OFF. When not in use, the landing

light retracts flush with the fuselage skin just forward of the nose gear wheel well. The landing light lamp switch at the right of the extension switch can be placed ON or OFF to turn the landing light on or off. The lamp can be turned on before it is extended so that the heat generated by the 28-volt d-c lamp filament can de-ice the landing light assembly, if required. When the landing light is retracted, the landing light lamp switch must be used to turn off the lamp.

CAUTION

The lamp filament generates intense heat; therefore, the light should not burn longer than necessary after landing.

Taxi Light and Control Switch.

On airplanes not equipped with nose wheel steering, a taxi light on the nose gear strut is controlled by the taxi light switch (figure 4-19) on the pilot's left vertical console. The switch has ON and OFF positions to energize and deenergize the 28-volt d-c lamp circuit.

Landing-Taxi Light and Control Switches.

On airplanes equipped with nose wheel steering, a single retractable light, located on the underside of the fuselage nose section just forward of the nose wheel, serves for both landing and taxiing. The light is controlled by two switches (figure 4-19) on the left vertical console: an extension-retraction switch with EXTEND, RETRACT, and OFF positions; and a light switch with LANDING, TAXI, and OFF positions. The light is extended or retracted by placing the extension-retraction switch at EXTEND or RETRACT. The light may be stopped in any position along the arc of travel by placing the switch at OFF. Extension or retraction takes about 10 seconds. Limit switches automatically stop the extension-retraction motor when the light is fully extended or retracted. The light is turned on and off by the light switch. When the switch is placed at LANDING (with the extension-retraction switch at EXTEND), the light burns at maximum intensity and is positioned at the correct angle for landing (or takeoff). When the switch is placed at TAXI (with the extension-retraction switch at EXTEND), the light is positioned at the correct angle for taxiing (about 7 degrees higher beam than for landing) and the light beam widens and dims. The light can be turned on before extension if necessary so that the heat generated by the light filament will de-ice the light assembly. After retraction, the light must be turned off by the light switch. The light and control switches are powered by the 28-volt d-c bus.



Figure 4-19.

CAUTION

To prevent damage to the light by the intense heat it generates, do not use the light in the landing position longer than necessary nor use the light in taxi (or landing) position when the airplane is not moving.

Note

When changing from one position of the light (taxi or landing) to the other, the extension-retraction switch must be placed at EXTEND, otherwise the extension-retraction motor will not operate and the light will remain in the original position.

INTERIOR LIGHTING.

Pilot's Cockpit Lighting.

Red floodlights, operating on 28-volt dc, light the pilot's instrument panel and cockpit area. Two are on the movable section of the instrument panel glare shield; others are on the left side and right side of the cockpit structure. Three red floodlights, spaced evenly below the rail on each side of the cockpit, light the pilot's consoles. Red bulbs under individual ring-type, hinged lighting shields illuminate the flight instruments, the fuel flowmeter indicators, and the fuel quantity gages. On Group 15 and subsequent airplanes, the engine instruments are lighted by the red floodlights. The lights for the engine instruments are on one circuit and the lights for the flight instruments on another, so that the two groups of lights can be used independently. Indirect plastic panel lighting is used for all other panels, control position indicators, and markings. A C-4 cockpit light with a removable red filter can be swiveled or removed from the mount. On Group 45 and subsequent airplanes, two rheostat-controlled thunderstorm lights, operating on 28-volt dc, are provided to counteract temporary blindness when eyes, adapted to the dark, are exposed to lighting flashes. These lights also provide interior illumination required for high-altitude daytime flying. They consist of two white floodlights mounted one on each side of the pilot's cockpit approximately 4 inches above the left and right consoles and aligned so that their light beams converge on the lower center of the instrument panel. On the cockpit lighting control panel individual rheostats are provided to control the operation and intensity of the floodlights, instrument ring lights, and indirect lighting. All lighting circuits for the pilot's cockpit are protected by circuit breakers on the pilot's circuit breaker panel. A stowage case for spare lights (figure 1-15) is attached to the bulkhead aft of the right console.

Pilot's Cockpit Lighting Rheostats. Six 28-volt d-c rheostats (figure 1-15), outboard of the pilot's right console, rotate from OFF to DIM to BRIGHT to control the pilot's cockpit lighting circuits. The first rheostat, at the forward end of the pilot's cockpit lighting control panel, controls the plastic panel lights; the second, the console lights. The third controls the instrument panel floodlighting, and the fourth, the console floodlighting. The fifth rheostat controls the ring lighting for the flight instruments; the sixth, the ring lighting for the fuel flowmeter and the three fuel quantity gages. On Group 15 and subsequent airplanes, the sixth rheostat controls the floodlighting for the eight engine instruments. On Group 45 and subsequent airplanes, a thunderstorm lights rheostat (figure 1-12), mounted outboard of the pilot's right vertical console, rotates from OFF to DIM to BRIGHT to control both thunderstorm lights.

Radar Observer's Cockpit Lighting.

Two 28-volt d-c red floodlights, mounted under the radar observer's glare shield, light the cockpit area. Two red bulbs under individual ring-type lighting shields illuminate each instrument on the instrument panel. The shields are hinged to permit replacement of the bulbs. All other panels have indirect or floodlight lighting. A C-4 cockpit light can be swiveled or removed from its mount for either red or white lighting. Rheostats control the operation and intensity of the floodlights, instrument ring lights, and indirect panel lighting. The circuit breakers for the lights are on the radar observer's circuit breaker panel.

Radar Observer's Cockpit Lighting Rheostats.

On Groups 1 through 30 airplanes, three 28-volt d-c rheostats (figure 4-7), located on the interior lights control panel, rotate from OFF to DIM to BRIGHT. The rheostat at the top of the panel controls the indirect panel lighting; the middle rheostat controls the instrument floodlights; the bottom rheostat controls the panel console lights. On Group 35 and subsequent airplanes, four rheostats, located forward of the alternator control panel in the radar observer's cockpit, provide means for regulating the radar observer's cockpit lighting. These rheostats rotate from OFF to DIM to BRIGHT. The rheostat at the top left controls the lighting of the console plastic panels; the one at the top right controls the instrument and circuit breaker floodlights; the one at the bottom left controls the console floodlights; and the bottom right rheostat controls the instrument indirect lights.

Pilot's and Radar Observer's C-4 Cockpit Lights.

A removable 28-volt d-c swivel-mounted C-4 cockpit light with a red filter is on the right side of each cockpit. The pilot's light is stowed on the left console with an alternate socket on the left windshield frame. A knob near the back of the light case turns the light on and off, and controls its intensity. A white, spring-loaded button on the back of the case can be pressed for momentary lighting. A small knob extending through a groove on the side of the case can be moved for spot- or floodlighting; tightening the knob screw locks the shield in any position. The red filter can be removed, if white light is desired.

OXYGEN SYSTEM.

The airplane is equipped with a gaseous oxygen system with an operating pressure of 400 to 450 psi. The oxygen is carried in four oxygen cylinders which are check-valved and installed in the aft fuselage for combat safety. Two of the cylinders supply oxygen to the pilot, and two supply the radar observer. Each crew-member's supply system is separate and there is no interconnection except that all four bottles can be filled through the same filler valve (figure 1-45) on the

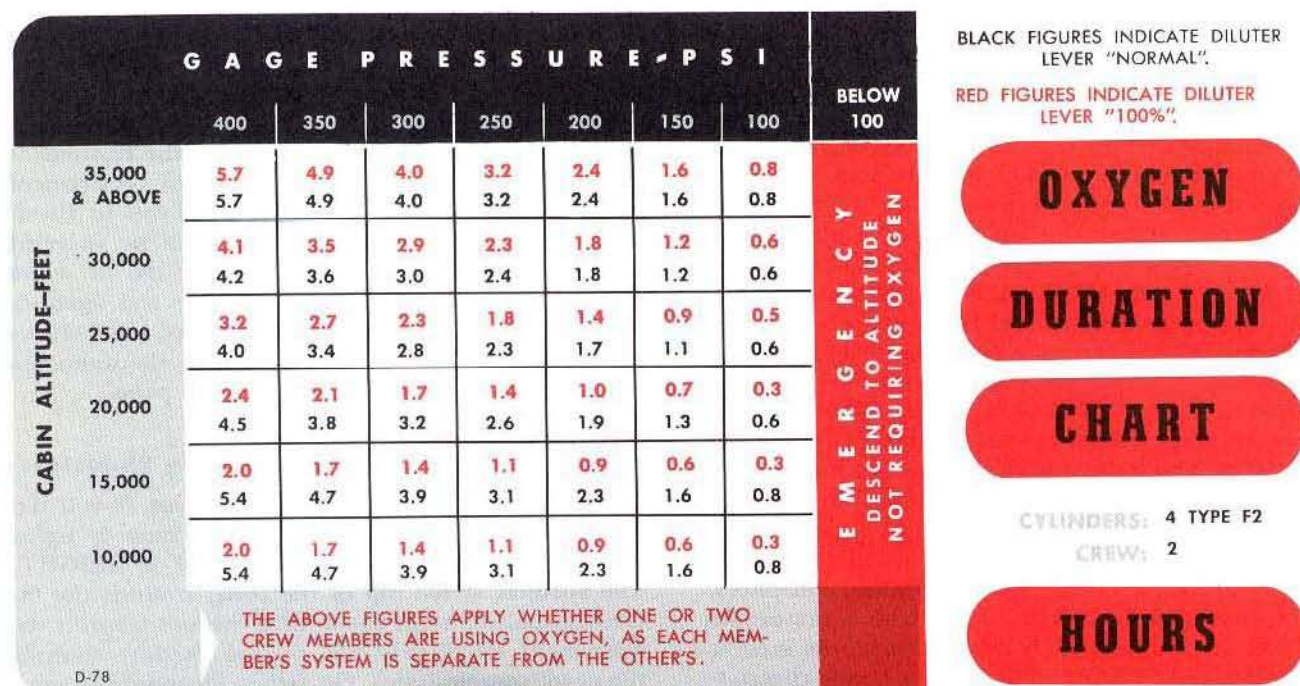


Figure 4-20.

left side of the fuselage near the trailing edge of the wing. On each crewmember's right console is an oxygen regulator panel which contains the oxygen system controls. A pressure-demand oxygen mask should be used with this system. The approximate duration of the oxygen supply at various altitudes is given in figure 4-20.

Oxygen Regulator

A diluter-demand oxygen regulator with a pressure gage and flow indicator (figure 4-21) is in the oxygen regulator control panel on the right console of each cockpit. From sea level to 30,000 feet (cabin altitude) the regulator automatically varies the ratio of oxygen to air to supply the proper mixture to the crew. Above 30,000 feet (cabin altitude), where the regulator delivers pure oxygen, the oxygen pressure increases sharply with altitude until the regulator delivers maximum pressure. A relief valve in the regulator prevents excessive pressure in the oxygen mask.

REGULATOR SUPPLY LEVER.

The oxygen supply lever (figure 4-21) on the regulator panel controls oxygen flow to the regulator. The radar observer's oxygen supply lever should be turned OFF whenever the radar observer's regulator is not being used. If it is left at ON, oxygen will be lost. The supply lever in the pilot's cockpit is safetywired in the ON position.

Note



Because of the automatic pressure-breathing feature of the regulator, a continuous flow of oxygen at altitude will result if the regulator is not being used and the supply lever is left at ON. This condition causes a rapid loss of oxygen at altitude.

REGULATOR DILUTER LEVER.

The diluter lever (figure 4-21) on the oxygen regulator panel has two positions: **NORMAL OXYGEN** and **100% OXYGEN**. When the lever is at **NORMAL OXYGEN**, the regulator automatically varies the ratio of oxygen to air and supplies the proper mixture to the crew from sea level to 30,000 feet (cabin altitude). Above 30,000 feet (cabin altitude) the regulator delivers pure oxygen. At any altitude, the diluter lever can be turned to **100% OXYGEN** if pure oxygen is desired for emergencies.

REGULATOR EMERGENCY LEVER.

The emergency toggle lever should remain in the center position at all times, unless an unscheduled pressure increase is required. Moving the toggle lever either way from its center position provides continuous positive pressure to the mask for emergency use. When the lever is depressed in the center position, it provides positive pressure to test the mask for leaks.

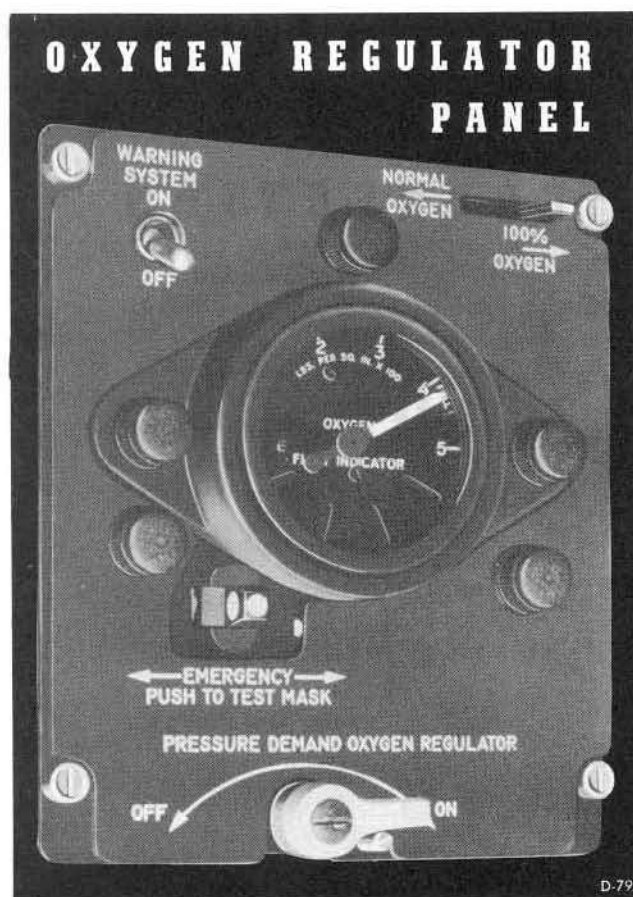


Figure 4-21.

CAUTION

When positive pressures are required, it is mandatory that the oxygen mask be well fitted to the face. Unless special precautions are taken to insure no leakage, continued use of positive pressure under these conditions will result in rapid depletion of the oxygen supply.

REGULATOR WARNING SYSTEM SWITCH AND INDICATOR LIGHTS.**Note**

On airplanes in compliance with T.O. 1F-1-533, the oxygen warning system has been rendered inoperative.

The warning system switch (figure 4-21) on the oxygen regulator panel can be placed at **ON** or **OFF** to control the oxygen warning lights. Two warning lights are on the instrument panels (figure 1-8 and figure 4-6) in the pilot's and radar observer's cockpits. One light indicates breathing in the pilot's mask; the other indicates breathing in the radar observer's mask. When the warning system switch is **ON**, the light dims when oxygen is being used, and glows brightly when oxygen is not being used.

Note

At flight altitudes below 10,000 feet with the oxygen regulator operating and the mask being used, the lights may blink brightly. Since this can happen only at low altitudes, it should not cause undue concern. The oxygen regulator warning circuit may be turned off below 10,000-foot flight altitude since the possibility of hypoxia is critical only at higher altitudes.

OXYGEN SYSTEM PRESSURE GAGE AND FLOW INDICATOR.

A combination pressure gage and flow indicator (figure 4-21) on the oxygen regulator panel registers the pressure of the oxygen supply on the upper half of the dial. In the lower half of the dial, the slots in the flow indicator are luminous when oxygen is flowing through the regulator; dull black when it is not.

Note

As an airplane ascends to higher altitudes where the temperature normally is quite low, the oxygen cylinders become chilled. As the cylinders grow colder, the oxygen gage pressure is reduced, sometimes quite rapidly. With a 100°F decrease in cylinder temperature, the gage pressure can be expected to drop 20 percent. This rapid fall in pressure

is occasionally a cause for unnecessary alarm. All the oxygen is still there, and as the airplane descends to warmer altitudes, the pressure will tend to rise again, so that the rate of oxygen usage may appear to be slower than normal. A rapid fall in oxygen pressure while the airplane is in level flight, or while it is descending, is not ordinarily due to falling temperature, of course. When this happens, leakage or loss of oxygen must be suspected.

OXYGEN SYSTEM PREFLIGHT CHECK.

1. Fasten the attachment strap on the mask male connector to the parachute chest strap by routing the connector strap up under the chest strap as close to the center as possible, down in front of the chest strap, and around again; then snap it to the connector.

WARNING

It is imperative that the connector tiedown strap on the mask male connector not be single-looped around the parachute chest strap

or attached to the chest strap snap. Failure to double loop the connector tiedown strap around the parachute chest strap will result in the tiedown strap slipping onto the snap of the chest strap and inadvertently opening the snap during bailout. See figure 4-22.

2. Connect the mask-to-regulator-tubing female disconnect to the mask male connector; listen for the click and look to see that the sealing gasket is only half exposed.

3. Attach the alligator clip to the end of the mask male connector strap. See figure 4-22.

4. Check oxygen regulator with diluter valve first at NORMAL OXYGEN and then at 100% OXYGEN by blowing gently into the end of the regulator tube as during normal exhalation. If there is resistance to blowing, the system is satisfactory. Little or no resistance to blowing indicates a leak or malfunction.

Note

Item pertaining to the oxygen warning light system applies only to airplanes not modified to T.O. 1F-1-533.

OXYGEN MASK CONNECTION



D-80

Figure 4-22.

5. Place oxygen warning light switches at ON. Warning light should emit a bright (steady or blinking) light. Move emergency toggle from center (OFF) to LEFT or RIGHT position. The warning light should change from a bright light to a filament glow and back to a bright light. Return emergency toggle to center (OFF) position.

6. With regulator supply valve at ON, oxygen mask connected to regulator, diluter lever at 100% OXYGEN, and normal breathing, conduct the following check:

(a) Blinker — observe for proper operation. Warning light should change from bright to a dim filament glow.

(b) Emergency toggle — deflect right or left. A positive pressure should be supplied to mask. Hold breath to determine if there is leakage around mask. Return emergency toggle to center; positive pressure should cease.

7. Diluter lever — return to NORMAL OXYGEN.

OXYGEN SYSTEM NORMAL OPERATION.

Note

Items pertaining to the oxygen warning light system apply only to airplanes not modified to T.O. 1F-1-533.

1. Regulator diluter lever—NORMAL OXYGEN.
2. Regulator supply lever—ON.
3. Regulator warning system switch—ON.

OXYGEN SYSTEM EMERGENCY OPERATION.

If either of the crew detects symptoms of hypoxia, or if smoke or fuel fumes enter the cabin:

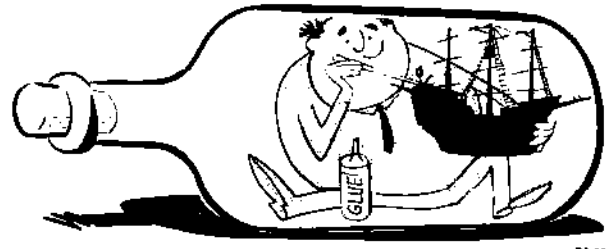
1. Regulator diluter lever—100% OXYGEN.
2. Regulator emergency lever—Push in and hold momentarily to clear mask.

Note

The duration of the oxygen supply is reduced when either of the crew turns to 100% OXYGEN or holds the oxygen emergency lever in.

3. Oxygen diluter lever—NORMAL OXYGEN after the emergency. If the oxygen regulator fails or if the mask develops a severe leak, push the regulator emergency lever right or left. If necessary, pull the cord of the bailout bottle.

WARNING



If either crewmember uses his bailout bottle, the pilot must descend immediately to an altitude not requiring oxygen.

AUTOPILOT (GROUP 35 AND SUBSEQUENT AIRPLANES).

An E-11 all-electric autopilot, powered by the 28-volt d-c main bus and the 115-volt a-c secondary No. 2 single-phase inverter bus, can be used to fly the airplane in straight and level flight, coordinated turns, climbs and descents (with or without maneuvering turns), and instrument approaches. It can be engaged, without producing abrupt changes in control or airplane attitude, at any time the airplane is being flown within autopilot engaging limits. This is due to an automatic synchronization system which keeps the autopilot bridge circuits electrically in trim during the time the autopilot is disengaged. The autopilot can be manually overpowered with the control stick and rudder pedals. Autopilot controls (figure 4-23) are grouped in two panels, the function selector and the flight controller, both located on the pilot's right console. Autopilot controlled flight at constant altitude is made possible by an altitude control which derives its signal from a sensitive aneroid system. Signals from the directional indicator provide a directional reference when the manual turn control is not being used. A vertical gyro provides a reference for measuring airplane displacement in the roll and pitch axes. Three rate gyros (yaw, roll, and pitch) supply signals proportional to rate of change in airplane displacement. When these signals are added algebraically to the signal provided by the vertical gyro, the result is a smooth coordination of the flight controls in both the starting of maneuvers and the return to straight and level flight. When the autopilot is engaged and the autotrim switch is at ON, the airplane's elevator trim system is operated automatically to minimize stick forces at the time of autopilot disengagement. A localizer coupler and glide-slope coupler provide means for automatic flight control during the approach and glide-slope phases of instrument landing procedure. After the autopilot is engaged it will control the airplane through a maximum of 60 degrees

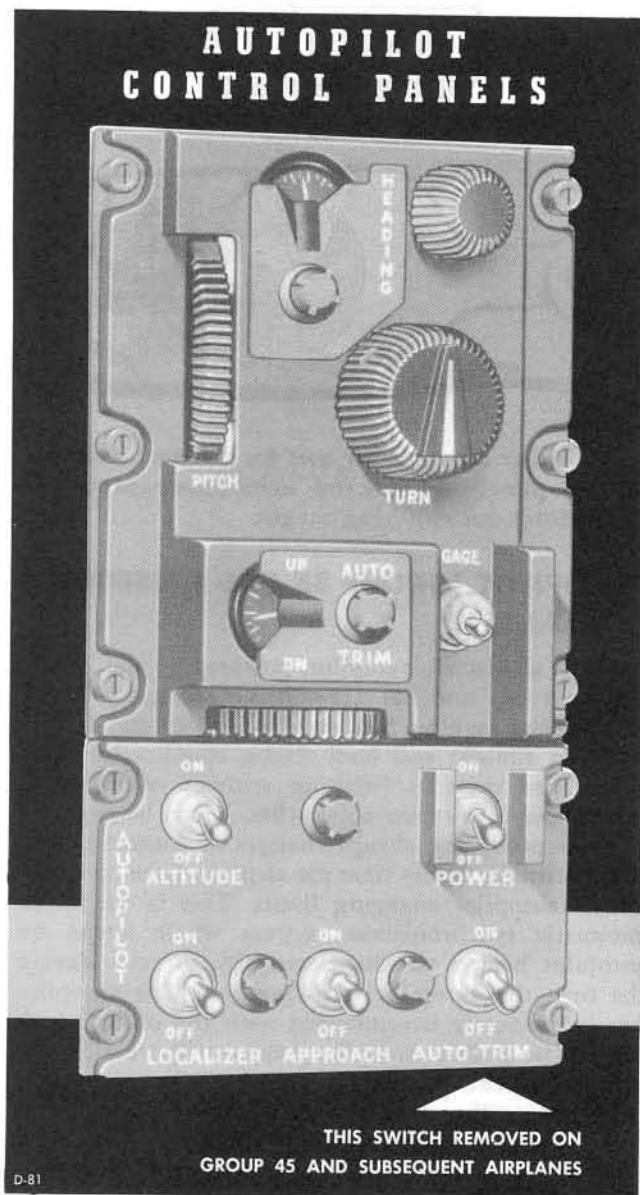


Figure 4-23.

of roll and 50 degrees of pitch in either direction from the horizontal. The engaging limits are 50 degrees of pitch, 29 degrees of roll, and 10 degrees of yaw. The elevator servo contains a slip clutch which limits the servo output to 13 pounds of stick force in the pitch axis. This limits "G's" during autopilot controlled flight to a safe value for all flight conditions. On Groups 35 through 55 airplanes an aileron travel limiter is incorporated in the autopilot system. This limiter is provided as a safety measure to be used when the autopilot is engaged with pylon tank fuel or tip tank fuel aboard the airplane. The limiter consists of two aileron limit switches, one at each aileron, a manually controlled switch, and a disengagement indicator light; all are in a separate electrical circuit that is tied into the autopilot system

between the autopilot engaging switch and the pilot's autopilot disconnect switch. When the aileron limiter circuit is energized, aileron deflection of approximately 5 degrees (at either aileron) will automatically disengage the autopilot and turn on an indicator light. The light will continue to burn and the autopilot cannot be reengaged until the pilot's disconnect switch is actuated. This will put out the light and reset the engaging circuit so that the autopilot can be engaged again. When the aileron limiter circuit is not energized, the maximum autopilot aileron deflection is 10 degrees. Group 60 and subsequent airplanes are not equipped with aileron limiter systems; however, the autopilot aileron deflection is limited to 5 degrees. When the autopilot is engaged, the airplane displacement signals to the sideslip stability augments are interrupted, but the latter system remains in standby status and will resume its stabilizing function the instant that the autopilot is disengaged.

Note

On airplanes AF52-1830 through AF52-1855 of Group 35 airplanes, the autopilot is electrically disconnected.

POWER SWITCH.

An autopilot power switch (figure 4-23), located on the function selector panel, controls the electrical power supply to the autopilot system. When the switch is placed at ON, power is supplied to the autopilot system. When the switch is placed at OFF, all electrical power to the autopilot is disconnected and the engaging switch, if at ENGAGE, snaps to OFF.

ENGAGING SWITCH.

The autopilot engaging switch (figure 4-23), located on the flight controller panel, has ENGAGE and OFF positions. The switch is solenoid-held and it will remain in the ENGAGE position only when the following conditions have been met: the autopilot circuit breakers are IN, the power switch has been at ON for 90 seconds or more, the turn knob on the flight controller is in detent, and the airplane is in an attitude within autopilot engaging limits. When the engaging switch is placed at OFF, the autopilot disengages. The switch will snap to the OFF position if the power switch is turned to OFF or if the pilot's emergency disconnect switch is used to disengage the autopilot.

Note

On Groups 35 through 65 airplanes this switch will also snap to OFF if the autopilot is automatically disengaged by the aileron travel limiter.

EMERGENCY DISCONNECT SWITCH.

A 28-volt d-c spring-loaded lever-type emergency disconnect switch (figure 1-30), located on the control

stick grip, provides a means of instantaneous autopilot disengagement. If the autopilot is engaged, squeezing the emergency disconnect switch will disengage the autopilot and cause the engaging switch to snap to OFF. The autopilot power switch will remain at ON until manually moved to OFF. When the emergency disconnect switch is used to disengage the autopilot, any of the solenoid-held coupler switches that may be at ON at the time (altitude switch, localizer switch, or approach switch) will snap to OFF. Squeezing the emergency disconnect switch also will reset the autopilot engaging circuit and turn off the indicator light if the aileron travel limiter system has automatically disengaged the autopilot (see Aileron Travel Limiter Switch and Indicator Light, this section).

TURN KNOB.

A turn knob (figure 4-23), located on the flight controller panel, provides a means of making coordinated turns with the autopilot. The knob normally rests in a neutral detent (knob pointing forward). When the knob is in this position, directional signals from the airplane's directional indicator provide the autopilot with a heading or directional reference. Moving the turn control knob to the right or left out of the detent will result in an autopilot-controlled coordinated turn in the direction that the knob is turned and at a bank angle proportional to the amount the knob is turned, up to a maximum bank angle of 60 degrees. When the turn knob is returned to the neutral detent the airplane will roll smoothly out of the turn and continue to fly at the new compass heading. The autopilot will not engage with the turn knob out of detent.

HEADING TRIM INDICATOR AND KNOB.

A heading trim indicator and heading trim knob (figure 4-23), located on the flight controller panel, are used to indicate and correct heading mistrim during autopilot-controlled flight. To correct heading mistrim, rotate the heading knob in direction of needle deflection: clockwise for right needle deflection, counterclockwise for left needle deflection.

Note

The heading trim indicator will indicate a mistrim condition whenever the autopilot is engaged, with the airplane in a bank. It will also indicate a mistrim condition whenever lateral trim conditions change during autopilot-controlled flight. To eliminate the requirement for trimming after engagement, it is recommended that the autopilot be engaged with the airplane in a coordinated zero-bank attitude.

PITCH KNOB.

A pitch control knob (figure 4-23), located on the flight controller panel, is used to control the airplane

in climbs and descents (when the altitude control is not engaged) and to trim for level flight. The pitch control may also be used in coordination with the turn control for combined maneuvers. Rotating the knob forward lowers the nose; rotating the knob aft raises the nose.

ROLL KNOB.

A roll trim knob (figure 4-23) on the flight controller panel is used to center the ball on the turn and slip indicator after engagement of the autopilot. Rotate the knob clockwise for a ball-left condition, counterclockwise for a ball-right condition.

Note

It will be necessary to use the roll trim knob only if the autopilot is engaged when the airplane is flying in an uncoordinated manner. If the autopilot is engaged during uncoordinated flight, it is usually faster to disengage the autopilot, trim for coordinated flight manually, and reengage. The autopilot will synchronize with the new flight attitude automatically, thus eliminating the need for using the roll trim knob.

AUTOTRIM SWITCH AND INDICATOR.

Groups 35 and 40 airplanes are equipped with an autotrim switch (figure 4-23) located on the function selector panel. On some of these airplanes the autotrim switch has been disconnected internally, and circuits have been changed to provide automatic engagement of the autotrim function whenever the autopilot is engaged. On Group 45 and subsequent airplanes the autotrim switch is eliminated from the selector panel; however, the autotrim circuit is maintained. When the autopilot is engaged (autotrim switch must be at ON) the elevator force trim system is operated automatically to minimize stick forces at disengagement. The elevator trim switch on the stick is deenergized when the autopilot is engaged. The autotrim indicator (figure 4-23) on the flight controller panel indicates whether or not the system is operating properly. When the autotrim system is operating properly, the trim indicator pointer will fluctuate to either side of center. If there is a malfunction in the system the pointer will remain deflected to one side. If this condition is noted, speed should be reduced before disengaging the autopilot; otherwise the airplane may pitch sharply upon disengagement, thus imposing excessive "G's."

ALTITUDE SWITCH.

A solenoid-held altitude switch (figure 4-23), located on the function selector panel, connects the altitude control to the autopilot elevator bridge circuits. When the switch is at ON, the autopilot will fly the airplane accurately at the pressure altitude at which it was flying when the switch was turned to ON.

For a change in flight altitude, the switch is turned to OFF; the airplane is flown to the new altitude and trimmed for level flight; and then the switch is placed at ON. The altitude switch snaps to OFF if the autopilot is disengaged or if the ILS approach switch is moved to ON.

Note

The altitude switch can provide limited trim; however, the airplane should be trimmed for approximately level flight before placing the altitude switch at ON. When large trim changes are required, it is necessary to retrim manually by using the pitch control knob or by disengaging the autopilot, retrimming the airplane, and reengaging the autopilot and altitude control.

AILERON TRAVEL LIMITER SWITCH AND INDICATOR LIGHT (GROUPS 35 THROUGH 55 AIRPLANES).

A switch located at the left of the flight controller panel (figure 1-15) turns the aileron travel limiter on and off. When this switch is at ON and the autopilot is engaged, deflection of either aileron more than 5 degrees from streamline position will automatically disengage the autopilot to prevent excessive rate of rolling when pylon or tip tank fuel is carried. Simultaneously the automatic disengagement indicator light, located just forward of the limiter switch, will come on and remain on until the autopilot disconnect switch is pressed. Pressing the disconnect switch turns off the indicator light and resets the autopilot engaging circuit. This must be accomplished before the autopilot can be reengaged. The travel limiter switch should be placed at ON whenever pylon or tip tank fuel is carried and should not be moved to OFF until all of this fuel is depleted.

AUTOPILOT NORMAL OPERATION.

Ground Tests.

During engine runup and taxi phase, turn on and engage autopilot and perform ground check as detailed in Section II.

Normal Engaging Procedure.

The autopilot can be engaged at any time the airplane is flying within the autopilot engaging limits. Engage the autopilot as follows:

1. Power switch—ON (1 1/2- to 2-minute warmup required).
2. Turn knob—Detent position.
3. Autotrim switch—ON.
4. Trim the airplane for coordinated zero-bank attitude within ± 50 -degree pitch attitude.
5. Engaging switch—ENGAGE. Switch will hold

in ENGAGE position if proper conditions for engagement have been met; otherwise the switch will snap back when released.

6. Autotrim indicator—Check that needle is fluctuating about center.

7. Aileron travel limiter switch (Groups 35 through 55 airplanes)—ON if pylon or tip tank fuel is carried.

Engaging Procedure in Turns or Uncoordinated Flight.

When the autopilot is engaged in turns or in uncoordinated flight, it will be necessary to trim the autopilot as follows:

1. Center the ball on the turn and slip indicator using the roll trim knob. Rotate the knob clockwise for ball left, counterclockwise for ball right.
2. Center the needle on the heading trim indicator using the heading trim knob. Rotate the knob clockwise for right needle, counterclockwise for left needle. It is usually quicker and easier, however, to disengage the autopilot, trim the airplane for coordinated zero-bank attitude, and reengage the autopilot.

Autopilot Trimming Procedure.

1. Trim the airplane manually after takeoff.
2. After engaging autopilot, check the turn and slip indicator. If a ball-left or ball-right condition exists, center the ball by rotating the roll trim knob clockwise or counterclockwise respectively. Wings will level after this step and the following step are completed.
3. After centering the ball, check the heading trim indicator. If the needle is deflected, return it to approximate center by rotating the heading trim knob in the direction indicated by the needle.

If the airplane trim condition changes during flight on autopilot, always center the ball with the roll trim *before* centering the heading trim indicator needle. This procedure makes it possible to trim the autopilot precisely in one operation, and should always be used.

Straight and Level Flight.

Fly to the desired altitude, trim the airplane for approximate level flight, and place the altitude switch at ON. The autopilot will fly the airplane at the pressure altitude existing when the switch is placed at ON. (If the altitude switch is OFF, the autopilot will maintain the airplane in the pitch attitude established by the pitch control but will not necessarily maintain level flight.) When the turn control knob is in detent, the directional indicator establishes a heading reference to maintain the airplane in straight and level flight. If a lateral mistrim condition develops (such as would be caused by an unbalanced fuel load) the autopilot will maintain the airplane laterally level and in straight flight but with heading mistrim in the direction of the heavy wing. To compensate for this condition, center the heading trim indicator needle using the heading trim knob.

Maneuvering Flight.

Autopilot-controlled climbs and descents can be made using the pitch control knob (figure 4-23). (Altitude switch should be at OFF.) Rotate the pitch knob slowly and smoothly to change pitch attitude. If the pitch knob is rotated rapidly, thus calling for excessive "Gs," the "G" limiting clutch in the elevator servo will slip, and the airplane will not respond. To correct this situation, disengage the autopilot, trim the airplane to the desired attitude, and reengage the autopilot. The autopilot will maintain the new attitude until changed by means of the pitch knob. Pull-ups from shallow dives may be made using the pitch knob, but pull-ups from steep dives must be made manually. Coordinated turns can be made using the turn knob. Bank angle (and corresponding turning rate) will be proportional to turn knob rotation. When the turn knob is returned to detent, the airplane will return to level, ending the turn. After a 5-second delay (which allows the airplane to stabilize on the new heading), the autopilot will fly the airplane on the compass heading existing at that instant. Combined maneuvers can be made by coordinated use of the turn and pitch knobs.

Disengaging Procedure.

The autopilot may be disengaged in three ways: squeezing the disconnect switch (figure 1-30) on the control stick, moving the engaging switch (figure 4-23) to OFF, or moving the power switch (figure 4-23) to OFF. Squeezing the disconnect switch or moving the engaging switch to OFF leaves the autopilot in standby status (ready to operate as soon as it is reengaged). Moving the power switch to OFF turns off all electrical power to the autopilot, putting it completely out of operation. If it is left off for an appreciable length of time, a 1 1/2- to 2-minute warmup will be required before the autopilot can be used again. Normally the power switch should be at ON at all times during the flight.

AUTOPILOT EMERGENCY OPERATION.

If the autopilot system fails or functions erratically, disengage the autopilot, and turn the power switch (figure 4-23) to OFF. When the autopilot is disengaged, the sideslip stability augments will resume its normal function of directionally stabilizing the airplane.

AUTOMATIC APPROACH EQUIPMENT (GROUP 35 AND SUBSEQUENT AIRPLANES).

Automatic approach equipment is provided in the autopilot system. Localizer and glide-slope couplers enable the autopilot to use signals from the VHF navigation and VHF glide-slope receiver for reference in azimuth and elevation during autopilot-controlled ILS approaches. (The localizer coupler is not designed for autopilot-controlled flight on omnirange and should

not be used.) The signals fed to the localizer and glide-slope couplers are the same as those used to move the vertical and horizontal bars on the ILS course indicator. The localizer and glide-slope couplers supply autopilot signals to maintain the airplane at the center of the localizer and glide-slope beams, respectively. This equipment can be disengaged instantly by squeezing the autopilot emergency disconnect switch (figure 1-30) on the control stick.

LOCALIZER SWITCH.

A solenoid-held localizer switch (figure 4-23) on the function selector panel connects the localizer coupler to the autopilot. The switch has ON and OFF positions. When the switch is placed at ON (after the localizer beam has been intercepted according to standard ILS procedures), the coupler feeds signals to the autopilot to provide automatic bracketing and beam following. The localizer switch can be turned off manually, or will snap to OFF automatically when the approach switch (figure 4-23) is placed at ON, or when the autopilot is disengaged.

APPROACH SWITCH.

A solenoid-locked approach switch (figure 4-23) on the function selector panel connects the glide-slope coupler to the autopilot. The switch has ON and OFF positions. When the switch is placed at ON, the airplane noses down and follows the glide beam, and the localizer switch snaps to OFF. (The autopilot continues to receive localizer signals, however.) The approach switch cannot be turned to OFF manually. It snaps to OFF only when the autopilot is disengaged.

AUTOMATIC APPROACH EQUIPMENT OPERATION.

Refer to ILS—Autopilot-Controlled Approach, Section IX.

E-6 FIRE CONTROL SYSTEM.

The E-6 rocket-firing control system is an all-weather, airborne radar system that combines radar tracking and computing with the rocket fire computer. The function of the rocket-firing control system is to provide position information that enables the pilot and radar observer to locate an airborne target, maneuver the airplane to launch an attack, and automatically fire the rockets at the precise time necessary to obtain a hit on the target. The antenna, the receiver-transmitter unit, and the radar observer's scope are automatically pressurized to maintain a ground level pressure at all operating altitudes. The compressor and equipment necessary for pressurization are located in the forward fuselage section. A system pressure gage is located on the radar observer's radar control panel. A fail-safe pressure switch protects the E-6 fire control system from damage by cutting off its power in case of a malfunction of the radar pressurization system. The radar observer controls the equipment and

is responsible for the sequence of radar operations which enable the crew to complete an effective intercept mission. The pilot's radar scope provides a display during the attack operation, combining radar and computer data for rocket-firing guidance.

Note

Operation of the E-6 fire control system will result in complete malfunction of the AN/ARN-6 radio compass around 400 kc.

RADAR UNITS.

See figure 4-24.

Radar Antenna.

The antenna (figure 4-24) consists of a horn-feed that terminates the waveguide from the receiver-transmitter and the paraboloidal reflector. The beam radiated from the antenna is continuously deflected through a conical scan pattern by an off-centered, rotating dielectric lens positioned in front of the horn-feed. Rotation of the lens is at the rate of 4500 rpm (75 cycles per second). For antenna positioning there are two similar servo-loop drive systems for azimuth and elevation. Each system consists of a drive motor, position synchro generator, a circuit in the electronic control amplifier, and positioning circuits that include means for space stabilization. Mechanical movement of the antenna is produced by separate azimuth and elevation two-phase drive motors. The motors are controlled through the respective elevation and azimuth channels of the electronic control amplifier. Positioning functions for the antenna assembly correspond to the phases of system operation; different circuits are provided for search, handtrack, and attack operations.

Radar Receiver-Transmitter.

This unit consists of both the transmitter and the receiver (figure 4-24) for the radar system. The function of the transmitter section is to develop and radiate a high-powered, X-band, radio-frequency pulse which is fed through the waveguide to the antenna. The same antenna receives the reflected signals of the transmitted pulses and relays the information to the receiver section. The receiver section detects and amplifies the received signals and distributes them to the indicator and automatic-tracking sections.

Signal Data Converter.

During the attack phase, this unit processes the attack display information received from the radar and computer, and relays this information to the flight indicator. See figure 4-24.

Audio Frequency Amplifier.

This unit provides 400-cycle, 10-volt, three-phase a-c power for the elevation and deflection rate gyros. It also controls the temperature of the rate gyros. See figure 4-24.

Electronic Synchronizer.

The purpose of this unit is to generate synchronizing pulses that establish the pulse repetition of the radar system. The short pulse repetition rate is 910 pps and the long pulse repetition rate 416 pps; during ground-map and beacon operation the repetition rate is 330 pps. See figure 4-24.

Power Supply (Low Voltage).

Separate sections in this unit furnish regulated 300-volt d-c, regulated +150-volt d-c, and regulated -250-volt d-c power for the radar system. See figure 4-24.

Flight Data Computer.

This unit computes steering and firing data from signals received from the radar system. The information is then presented on the scopes to indicate the correct flight path for a successful interception. The unit provides a signal to the intervalometer to fire the rockets. See figure 4-24.

Computer Power Supply.

This power supply unit provides the regulated +250-volt d-c and regulated -250-volt d-c power for the flight data computer and the amplifier power supply. See figure 4-24.

Electronic Control Amplifier.

This unit supplies driving power to the elevation and azimuth antenna motors in search, hand control, and automatic track. See figure 4-24.

Amplifier Power Supply.

This unit generates a 500-cycle excitation and reference voltage for the deflection and elevation rate gyro circuits. Unregulated 250-volt d-c power is provided by a power supply in the unit. Angular rate signals from the rate gyros are also received and amplified in the unit and relayed to the resolving section of the computer. See figure 4-24.

Terminal Box.

This unit furnishes 115-volt, 400-cycle a-c standby power, 115-volt, 400-cycle a-c delayed standby power, and 28-volt d-c standby power to the complete system. See figure 4-24.

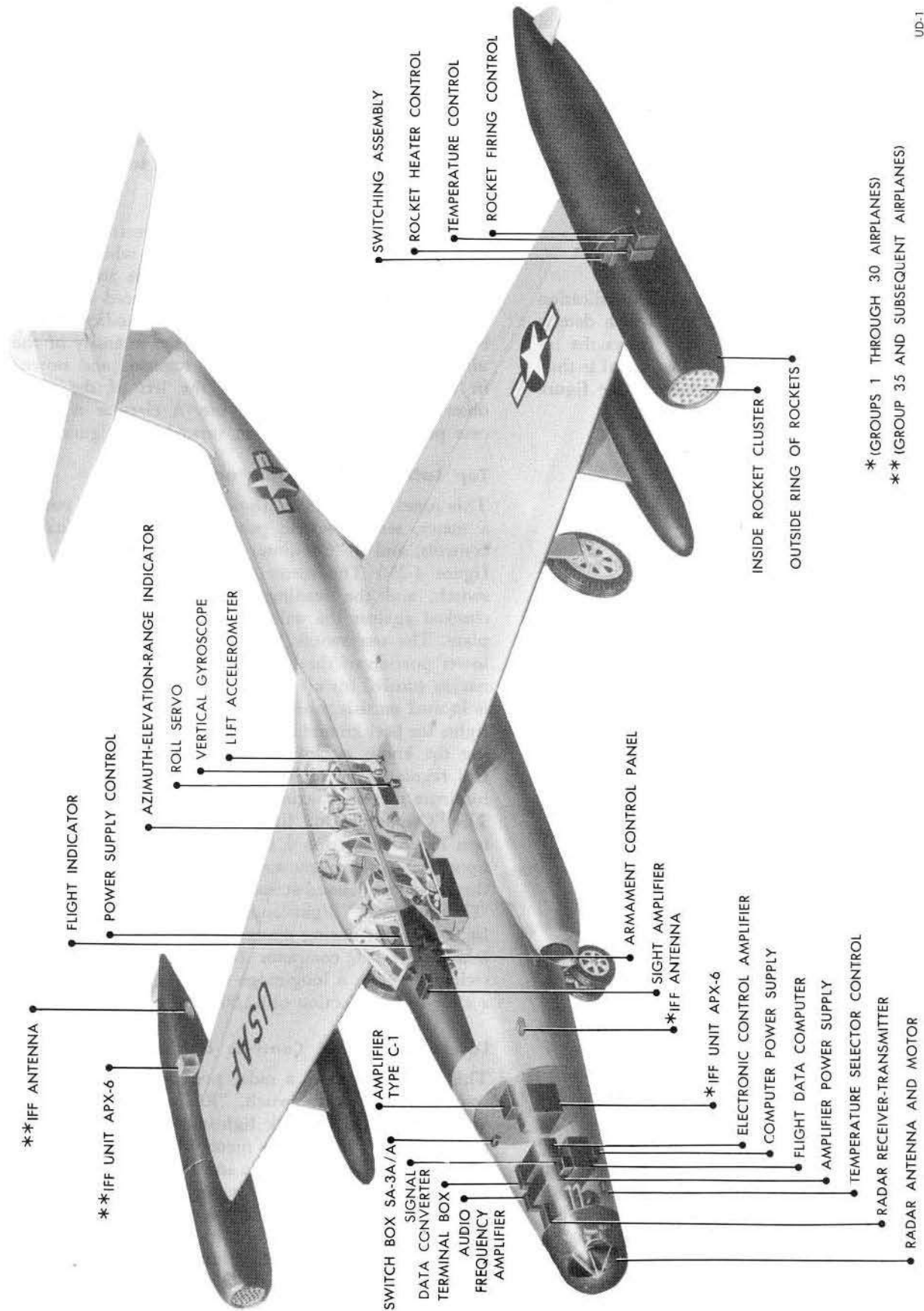
Vertical Gyroscope.

The roll attitude of the airplane is detected by this unit which relays the information to the roll resolver and pitch synchro for space stabilization of the antenna. See figure 4-24.

Roll Servo.

This electromechanical device receives signals representing the roll attitude of the airplane from a synchro transmitter on the vertical gyro (figure 4-24). The roll servo positions a shaft so that its angle with respect

UD-1



* (GROUPS 1 THROUGH 30 AIRPLANES)
 ** (GROUP 35 AND SUBSEQUENT AIRPLANES)

Figure 4-24.

ARMAMENT AND FIRE CONTROL EQUIPMENT

to the airplane equals the roll angle of the airplane; this in turn positions four resolvers and a control transformer. Two of these resolvers are used in the noise smoothing circuits of the elevation and azimuth steering sections, and the null-steering circuits. The third resolver is used in the circuit which provides the artificial horizon of the radar indicator. The fourth resolver is used in the circuit which provides space stabilization of the antenna during search operation. The control transformer is used in the roll servo circuit as the feedback element.

Lift Accelerometer.

This unit is a functional part of the quick-indication circuit in the elevation steering section, which detects the lift acceleration of the airplane and relays the information to the elevation amplifier. The signal is then transmitted to the signal smoothing circuit. See figure 4-24.

RADAR CONTROLS AND INDICATORS.

See figure 4-25.

Radar Observer's Scope.

The radar observer's scope (figure 4-25) provides information during all phases of operation. The indicator will display indications for ground mapping, beacon, search, and attack operations. The controls located on the indicator housing panel attached to the left side of this indicator provide search intensity control, anti-jam control, and IF gain control. The search intensity control knob governs the brilliance of the indicator. To increase brilliance, the knob is turned clockwise. The anti-jam control is used tactically to change transmitting frequency when necessary to avoid jamming by interfering radar frequencies. This control is a push-button switch for controlling a motor that tunes the transmitting magnetron within the effective tunable range of over 600 megacycles.

CAUTION

Viewing scope must be stowed in vertical position before stowing console. When stowing, console should be restrained by hand so that it will not strike bumpers hard enough to jar the set.

Anti-jam Control. By using the anti-jam pushbutton switch on the scope housing panel, the radar observer may select frequencies over a wide band. This provision enables the observer to avoid frequencies in use by other radar, or to avoid deliberate jamming. This switch should be used only when dictated by conditions of absolute necessity, and then by a very brief application of pressure to the switch.

CAUTION

The anti-jam control should not be used unless conditions demand a change in frequency. Operation of the anti-jam control should not exceed 30 seconds with at least 30 seconds between successive operations.

The IF gain control knob affects the sensitivity of the receiver and varies the signal level at which the indicator presentation appears. To increase the gain of the equipment the knob may be advanced clockwise as necessary. A red night-filter for the indicator may be attached to the scope to reduce the intensity of the video display. The filter may be removed and stowed in the parts stowage bag (at the left of the radar observer's seat) when not in use. A circular zippered case protects the filter when stowed. See figure 4-25.

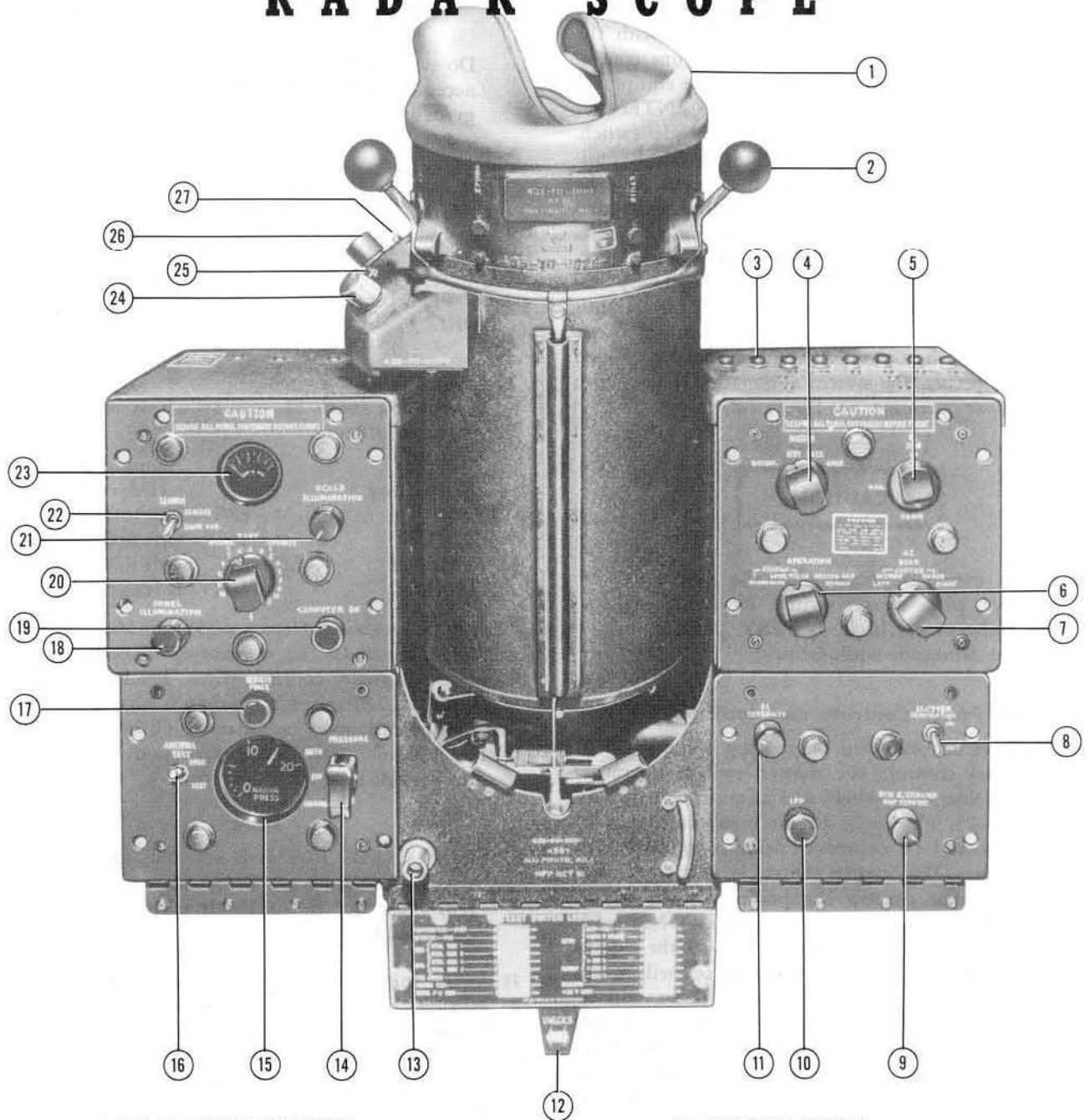
Top Left Panel Controls and Indicators.

This panel comprises an 18-position rotary test switch, a meter, search switch, panel and scale illumination controls, and a "Computer On" light indicator. (See figure 4-25.) The meter is associated with the test switch, and the readings obtained during tests are checked against the values shown on the test legend plate. The test switch legend plate is located on the lower portion of the radar console. The panel illumination control for all four panels of the radar console is located on this panel. The intensity of the concealed lights for background illumination is increased by turning the knobs clockwise. The scale illumination control regulates the intensity of the edge lights that illuminate the range, azimuth, and elevation calibrations. The "Computer On" light illuminates when the system has been on for $4\frac{1}{2}$ to 10 minutes, dependent upon ambient temperature. This stage is reached when the computer delayed-action circuits are energized. The "Computer On" light is a press-to-test type. If the light goes out during operation and relights when the lens is pressed, computer failure exists. The search switch provides a long-range selection of 30 miles and a close-range selection of 12,000 yards. See figure 4-25.

Lower Left Panel Controls and Indicators.

This panel comprises a radar pressure meter, pressure switch, antenna test switch, "Reduced Power" light, and four lights for back lighting of the panel. (See figure 4-25.) The pressure meter indicates the amount of pressure in the waveguide and rf systems. The meter is calibrated in pounds per square inch absolute (psia). The system pressurization is maintained automatically by a pressure regulator that controls a motor-driven pump. Additional control of the pump motor is obtained by the toggle switch at the right of the meter. The pump is under automatic control when the switch is in the ON position. By placing the switch in the

R A D A R S C O P E



- 1 RADAR OBSERVER'S SCOPE
- 2 LOCKING HANDLE
- 3 CIRCUIT BREAKER PANEL
- 4 MASTER SWITCH
- 5 ELEVATION SCAN SWITCH
- 6 OPERATION SWITCH
- 7 AZIMUTH SCAN SWITCH
- 8 CLUTTER ELIMINATOR SWITCH
- 9 BEACON & GROUND MAP CONTROL
- 10 IFF INDICATOR LIGHT
- 11 ELEVATION INTENSITY CONTROL
- 12 UNLOCKING LEVER
- 13 SCOPE ELEVATION ADJUSTMENT KNOB

- 14 PRESSURE SWITCH
- 15 RADAR PRESSURE METER
- 16 ANTENNA TEST SWITCH
- 17 REDUCED POWER LIGHT
- 18 PANEL ILLUMINATION SWITCH
- 19 COMPUTER-ON LIGHT
- 20 ROTARY TEST SWITCH
- 21 SCALE ILLUMINATION SWITCH
- 22 SEARCH SWITCH
- 23 TEST SWITCH METER
- 24 IF GAIN CONTROL
- 25 ANTI-JAM BUTTON
- 26 SEARCH INTENSITY CONTROL
- 27 IFF SWITCH

Figure 4-25.

MANUAL position, the regulator is bypassed and current is supplied directly to the pump. This provides control of radar pressurization in the event of failure of the automatic regulator system; however, with the switch in MANUAL position, the pump runs continuously and if pressure becomes excessive, the equipment may be damaged. The switch placarded ANTENNA TEST is a two-position spring-loaded toggle switch. During normal operation the switch is in OPER position. In flight or ground check the switch can be placed in the TEST position to determine the actual position of the antenna as it scans in azimuth and elevation. This position is indicated by a "C scan" presentation on the radar observer's indicator. The press-to-test type red monitor "Reduced Power" light illuminates only when certain types of overloading occur and may flash when changing pulse operation. When overloading occurs, the system automatically goes into reduced-power operation. See figure 4-25.

CAUTION

If the overload persists and the modulator goes off, place master switch, located on the top right panel, back to STBY position to prevent damage to equipment.

Top Right Panel Controls and Indicators.

Four switches are mounted on the top right panel of the radar set control: the master switch, operation switch, elevation scan switch, and azimuth scan switch. See figure 4-25. The eight circuit breakers on top of this panel should be depressed prior to operation of the equipment. The master switch is a four-position rotary-switch that governs the power applied to the radar system. Placing the switch in DISCONN position disconnects the input power line to the equipment. In the STBY position the radar set will warm up and after 4 1/2 minutes the delay timer will be energized. After the delay timer has closed, the system may be put into operation by placing the switch in OPER position. The EMER position provides a time delay of less than 4 1/2 minutes. It is necessary to pull the switch knob out from the panel before placing it in the EMER position. See figure 4-25.

WARNING

If the fire control system in this airplane is on at any time during flight, the fire control system master switch should not be turned to the disconnect position until the airplane is landed and parked.

CAUTION

Do not use the EMER position except when necessary, due to possible damage to the rate gyros and magnetron.

The elevation scan switch provides elevation scanning as follows:

<i>Switch Position</i>	<i>Elevation Scan (Degrees)</i>
UP	0 to 63
DOWN	0 to 43
HORIZ	0 to 68 1/2 left 0 to 68 1/2 right

The azimuth scan switch (figure 4-25) provides azimuth scanning (with EL scan switch at HORIZ) during search as follows:

<i>Switch Position</i>	<i>Azimuth Scan (Degrees)</i>
LEFT	68 1/2 Left to 11 Right
RIGHT	11 Left to 68 1/2 Right
NARROW	41 Left to 41 Right
BROAD	68 1/2 Left to 68 1/2 Right

The operation switch (figure 4-25) provides for search, ground-map and beacon operations. This switch is a four-position rotary control switch. Placing the switch at LONG PULSE gives a maximum power output to provide indications of target up to 60,000 yards ahead of the airplane. GROUND MAP and BEACON selections provide long pulse operation.

Note

When LONG PULSE is selected, the search switch should be at 30 MILES, and the system must not be in handtracking or automatic track.

If during this phase of operation a condition of power overload should occur, the switch must be placed in STBY, then SHORT PULSE position. Placing the switch in SHORT PULSE position reduces the average power. This position also provides better definition of grouped targets. Placing the operation switch at GROUND MAP position provides single-bar antenna scanning. In this position the 300-mile range scale is used on the indicator and the scan is confined to a single traverse centered at an elevation of -3 degrees. Placing the operation switch in BEACON position shifts the equipment to the required beacon frequency and operates at the same power output as in ground mapping. The single bar scan is retained in beacon operation, centered at 0 degree elevation.

Lower Right Panel Controls and Indicators.

This panel includes an IFF (press-to-test type) light which may be inoperative on some airplanes, elevation

intensity control knob, beacon and ground-map expand control, and a clutter eliminator switch. (See figure 4-25.) Two lights for backlighting are also included on this panel. The beacon and ground-map control knob is used to expand any 20-mile zone of the range sweep trace to cover the entire face of the radar indicator. By use of this knob the land mass patterns or beacon responses appear magnified and in greater detail on the radar indicator. This knob has two types of adjustment. Turning the knob to select the zone for expansion, and then pressing the control inward and holding in this position, enables the indicator to present an expanded display. When the knob is in the normal undepressed position and the GAIN knob is increased, two strobe lines appear 20 miles apart on the 200-mile range sweep trace as a guide to zone selection. When the knob is in maximum counterclockwise position, the strobe appears at zero range on the indicator. If the knob is depressed in this position, the indicator will display a coverage from zero to 20 miles. When the knob is placed in maximum clockwise position, the strobe appears at a position corresponding to 180 miles of range on the sweep trace. Depressing the knob in this position will give a scope display of the range zone between 180 and 200 miles. The clutter eliminator control has two positions placarded IN and OUT. The clutter eliminator is effective at slant ranges exceeding 8000 yards. Slant range is the exact range to the target. The suppressor circuit of the radar system terminates the range sweep at the range of these echoes. This removes the ground clutter and echoes from the indicator display at ranges from 8000 yards and over. Clutter is most likely to occur at the lowest bar of the two-bar raster scan. The clutter eliminator switch should normally be left in the OUT position. The IN position should only be used when clutter interference exists. The elevation intensity control knob regulates the brightness of the elevation pip. The pip represents the elevation of the antenna as it makes its horizontal traverse.

Antenna Hand Control.

One of two types of antenna hand control (figure 4-26) may be found in the airplane. The hand control is used to manually position the antenna after a target has been selected. One type hand control is cylindrical in shape and incorporates two control switches: an action switch and a rocker-type range switch. The other type hand control has a pistol grip shape and incorporates three switches: an action switch, rocker-type range switch, and a nose-tail switch. The pistol grip type control handle will be used only with systems employing both antenna hand control and an electrical synchronizer. The action switch must be depressed to start hand control operation. If the hand control is moved from the spring-loaded neutral position to any position within the azimuth and elevation limits of the system, the antenna will be moved in direct proportion. The rocker-type range switch control is provided on the handle to achieve range

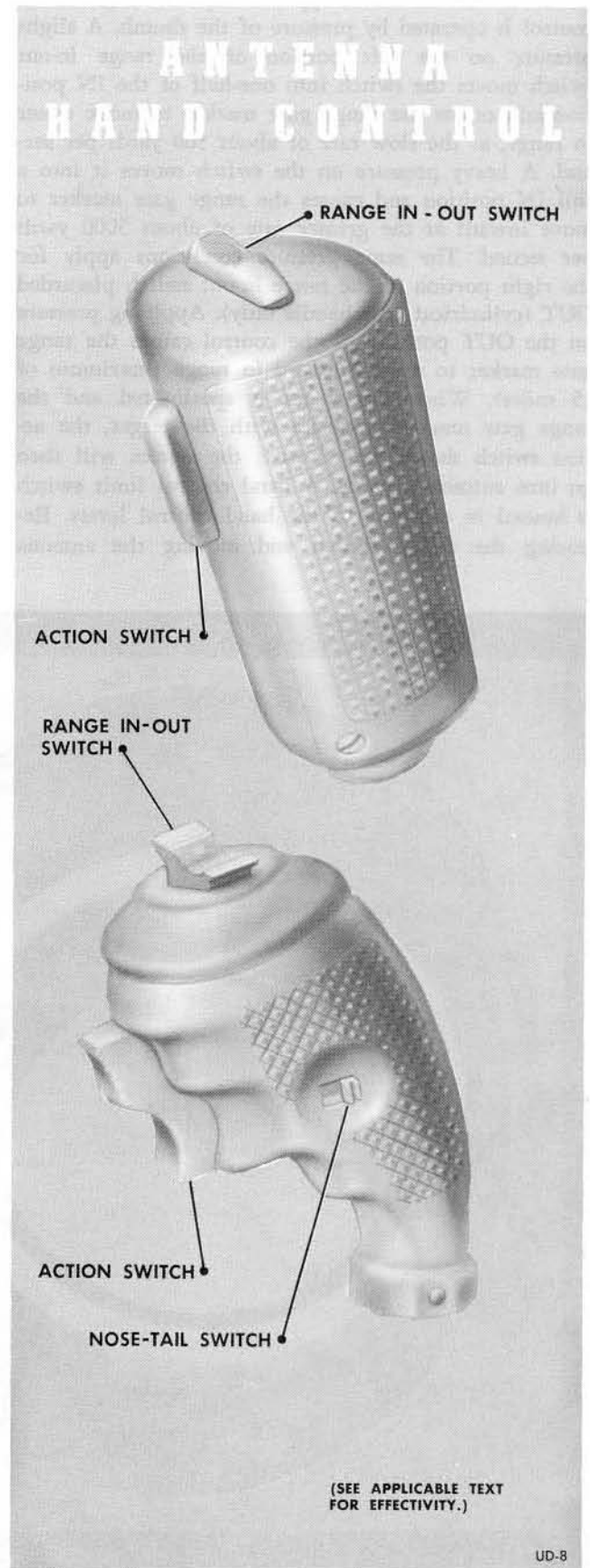


Figure 4-26.

coincidence. This rocker-type, two-speed, range in-out control is operated by pressure of the thumb. A slight pressure on the left portion of the range in-out switch moves the switch into one-half of the IN position and causes the range gate marker to move closer in range, at the slow rate of about 500 yards per second. A heavy pressure on the switch moves it into a full IN position and causes the range gate marker to move inward at the greater rate of about 5000 yards per second. The same pressure conditions apply for the right portion of the range in-out switch placarded OUT (cylindrical type handle only). Applying pressure on the OUT position of the control causes the range gate marker to move outward in range (maximum of 15 miles). When the target is spotlighted and the range gate marker coincides with the target, the action switch should be released; the system will then go into automatic track. A hand control limit switch is housed in the base of the hand control levers. Releasing the action switch and moving the antenna

hand control lever as far aft as possible will actuate the limit switch and transfer the system back into search operation. After the hand control limit switch has been actuated, a slight delay will occur; the antenna will then begin to scan normally. If while using the pistol grip type antenna hand control, the radar observer is confronted with multiple targets in the form of a combined echo, he may track either the leading or trailing edge of the combined echo by placing the nose-tail switch at the desired position. If the echo is not combined on a multiple target nose or tail attack, the radar observer may select the forward position on the nose-tail switch and the nearest target will automatically be tracked. If the aft position on the switch is selected, the farthest target will automatically be tracked. On a single target the switch position is immaterial.

Pilot's Scope.

The pilot's scope (figure 4-27) provides information to the pilot during the attack phase only, except for

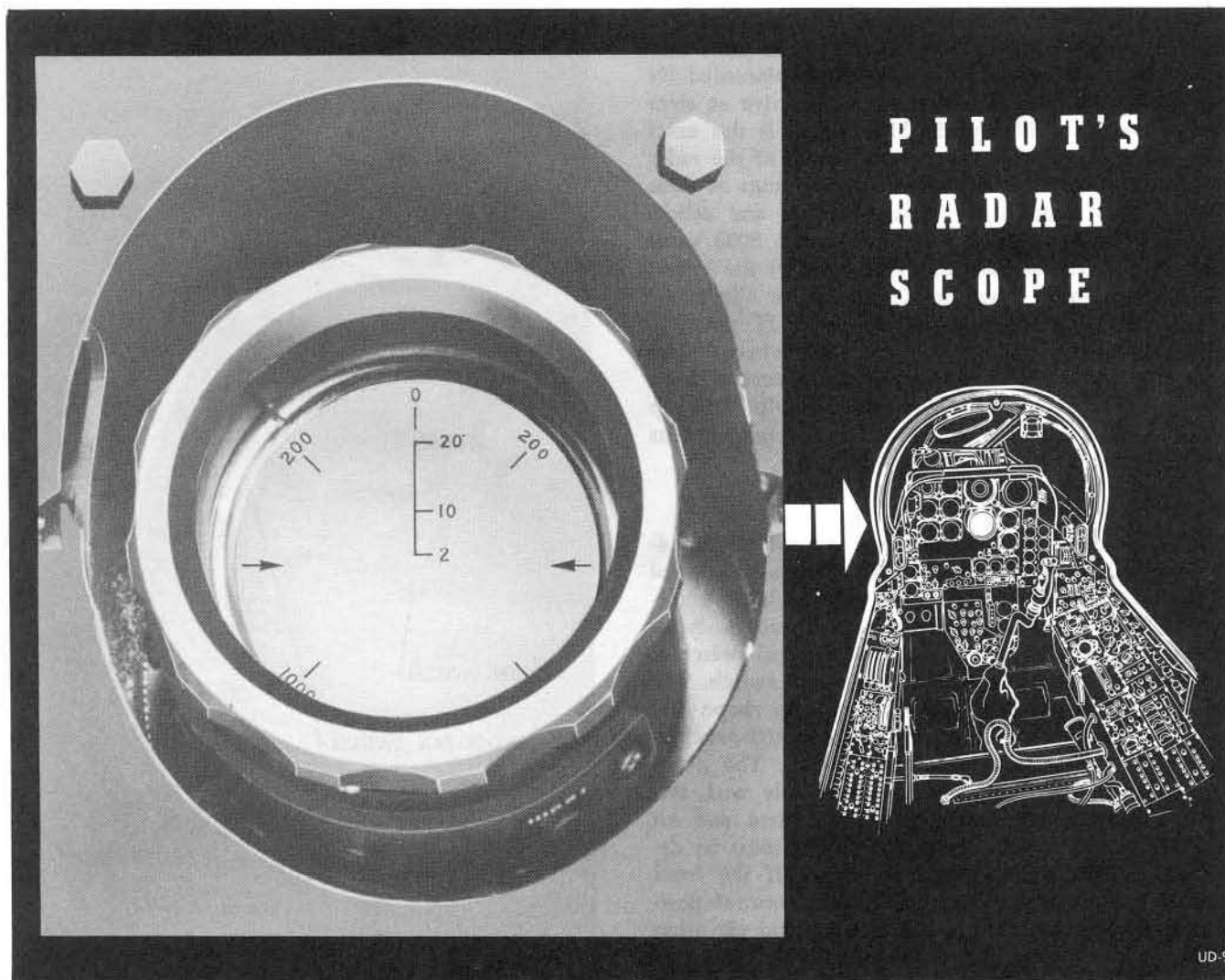


Figure 4-27.

the artificial horizon that is present in all phases of operation. The display consists of a steering dot, a reference circle, a time-to-go (until rocket impact) circle which is broken to indicate the rate of closure between the target and interceptor, and the artificial horizon. These elements of the display are combined by time-sharing and multiplexing circuits. A pullout signal, produced electronically, appears across the face of the indicator. The signal automatically illuminates at the instant rockets are fired. This pullout signal is also given to avoid collision with the target when the airplane approaches dangerously close to the target after straying from the computed course (overlead condition only). Two polaroid lenses, one stationary and one mounted within a fluted ring, cover the face of the scope to enable the pilot to vary the intensity of the scope display by rotating the lens ring.

Pilot's Scope Control Panel.

The pilot's scope control panel (figure 4-28), on the pilot's right vertical console, comprises a dual-purpose



Figure 4-28.

gyroscope erection control and a panel light. The gyro erection control compensates for airplane attitude due to changes in speed, loading, altitude, and air density, and is effective during all phases of operation.

Control-Power Supply Panel.

The control-power supply (figure 4-29) is mounted in the pilot's cockpit near the right console. Two operating controls are provided for the pilot's indicator display. The control regulates the intensity of the display,

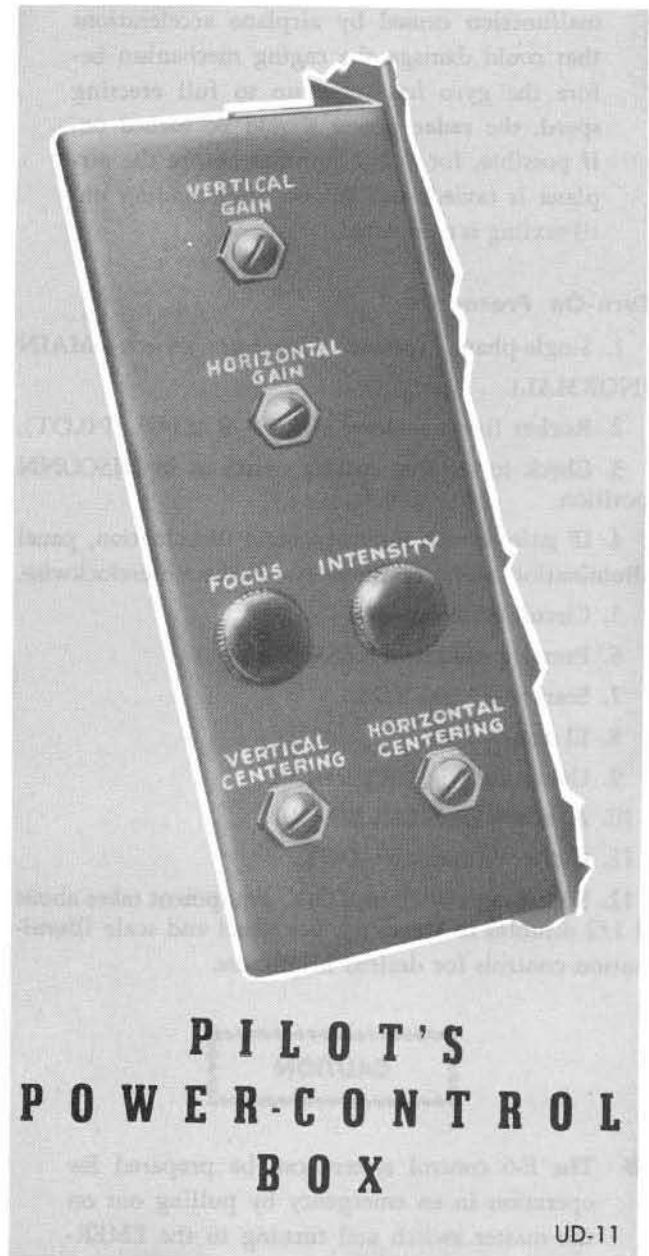


Figure 4-29.

clockwise rotation increasing the brightness. If the desired intensity cannot be obtained by rotation of the polaroid light filter of the indicator, the control may be adjusted to the correct level by the pilot. The control, also adjusted by the pilot, is used to obtain sharp focus of the pilot's scope display.

FIRE CONTROL SYSTEM NORMAL OPERATION.**CAUTION**

To protect the E-6 vertical gyro from possible malfunction caused by airplane accelerations that could damage the caging mechanism before the gyro has come up to full erecting speed, the radar power should be turned on, if possible, for 4 1/2 minutes before the airplane is taxied, and left on after landing until taxiing is completed.

Turn-On Procedure.

1. Single-phase (power) inverter switch—MAIN (NORMAL).
2. Rocket firing selector switch—RADAR (PILOT).
3. Check to see that master switch is in DISCONN position.
4. IF gain, search intensity, scale illumination, panel illumination, elevation intensity—Full counterclockwise.
5. Circuit breakers—IN.
6. Pressure switch—PRESSURE.
7. Search—12,000 YDS.
8. El scan—HOR.
9. Operation—SHORT PULSE.
10. Az scan—CENTER BOARD.
11. Clutter eliminator—OUT.
12. Set master switch to STBY. Equipment takes about 4 1/2 minutes to warm up. Set panel and scale illumination controls for desired brightness.

CAUTION

- The E-6 control system can be prepared for operation in an emergency by pulling out on the master switch and turning to the EMERGENCY position.
- Limit the use of the EMERGENCY position to emergency conditions, as major radar components will deteriorate rapidly as a result of starting without a normal warmup period.

13. Turn master switch to OPER when computer light comes on.

WARNING

Make sure that the range gate marker is ranged out before turning master switch to OPER. If the range gate marker is ranged in, a lockon to the transmitter pulse (main bang) may occur and the rockets will fire if the trigger is squeezed.

14. Adjust the IF gain control and search intensity for desired sensitivity. Adjust search intensity control for desired brightness. Adjust elevation intensity control for desired brightness.

Automatic Search.

1. When targets become apparent on the display, notify the pilot and adjust the IF gain and search intensity controls for the best display. When the targets are first detected, the radar observer should determine the optimum type of approach possible.
2. Advise the pilot of azimuth, elevation, range, and rate of closure of the selected target.

Note

- The radar observer must inform the pilot of the type of approach being made (i.e., head-on, beam, tail, etc) so that the correct pull-out can be made after the rockets are fired.
- When an attack is being made on a towed target, the radar observer must know the direction in which the tow plane is flying to determine which indication on the scope is the target.

Manual Search.

1. Recheck azimuth position of target.
2. Depress action switch on antenna control. Note appearance of range gate marker projecting leftward from range sweep trace at approximately 5 miles.
3. Move control handle laterally so that azimuth position of range sweep trace coincides with azimuth position of target.
4. Spotlight target for brightest echo return by moderate motion of antenna control in azimuth and elevation.
5. By pressure on range in-out switch, position range gate marker to coincide with target echo.
6. Release action switch to place system in automatic track.
7. Check that range gate marker remains locked on desired target. If locked on undesired target, release the system from automatic track and return to manual search by depressing the action switch. Then repeat steps 1 through 6.

8. Notify pilot that system is in automatic track and that attack display should be present on his scope.

Automatic Tracking.

1. After the pilot has been notified that the system is in automatic track, maintain a continuous check of the azimuth, elevation, and range of the target. Keep the pilot informed of the progress of the attack. If the airplane engages in violent maneuvers, check the scope display to assure that lockon has not been lost.

Note

Loss of lockon may result from improper adjustment of the IF gain control, or from clouds, strong ground return, and other interference. If the system falls out of automatic track operation, repeat the hand-tracking procedure to recover lockon. To return the system to handtracking, depress the action switch on the antenna hand control.

2. As phase I of the attack operation begins, fly the airplane to the dot so as to keep the steering dot within the fixed reference circle, or fly as directed by the radar observer.

Note

The computer is continuously computing an approximately straightline attack course, based upon instantaneous relative positions and velocities, and in centering the steering dot, the pilot achieves that course. If the airplane flies off-course or the target maneuvers from its path, the computer directs the airplane into a new straightline attack course.

3. Observe the time circle carefully, with respect to its size (indicating time-to-go), and the position of its blanked segment (indicating closing rate). Note that when time-to-go is reduced to 20 seconds (start of phase II), the reference circle contracts suddenly to about 1/4 inch in diameter, and the time circle begins to shrink. When the time-to-go circle begins to shrink, squeeze the control stick trigger and hold depressed until rockets fire or pullout signal appears on scope.

4. In phase II, note the diminishing size of the time circle, and read time-to-go directly from the superimposed scale. Subject to the more difficult limitations of the small reference circle, fly the airplane so as to keep the steering dot centered within the circle.

Note

The purpose of phase II is to direct the airplane into a more precise course. In most side approaches, phase III follows phase II. However, in the case of either a nose or a tail

cone approach to the target, the computer will complete the attack in phase II, firing the rockets and giving the pullout signal without entering phase III. Indication that completion of attack in phase II is about to take place is the failure of the reference circle to flatten into a straight line, even though the time circle has decreased to less than 4 1/2 seconds. To complete the attack under phase II, it is required that flying accuracy be increased so that the steering dot is as close as possible to within one half of its diameter of being exactly centered in the reference circle. The attack will be completed in phase II, if at 4 1/2 seconds to go before rocket impact, either the azimuth position of the antenna is less than ± 19 degrees, or if the rate of closure is less than 135 knots.

5. In phase III, note that time-to-go has decreased to 4 1/2 seconds. Note that the reference circle then flattens into a horizontal line, and that the steering dot provides elevation steering information only. Fly the airplane in elevation so that the steering dot remains on the horizontal line.

Note

Horizontal motion of the steering dot during phase III indicates roll angle. The dot always moves laterally toward the high wing if any roll angle is present in phase III. Use this information and the position of the artificial horizon to keep the airplane wings level. This is the final firing run and accurate elevation steering is most critical. As the attack run is completed, the rocket firing system is automatically readied and the rockets are fired in spaced salvos.

6. Remain alert for pullout signal. When the signal appears, release trigger (or hold depressed until break-lock occurs), execute a maximum acceleration turn, and pass astern of the target.

WARNING

Do not squeeze the trigger again after the rockets fire, as the firing circuits remain energized until time-to-go again becomes greater than 2 1/2 seconds. If the trigger is squeezed again after firing and time-to-go is less than 2 1/2 seconds, the next selected pass will fire.

7. Immediately after completing pass, pull back on the hand control to put antenna in search.

Ground Map Operation.

Place the operation switch (figure 4-25) at GROUND MAP. This places the radar set in long pulse operation, lowers the antenna 3 degrees, and presents a ground display of 200-mile range. Through proper orientation, the radar observer can use this as a navigation aid. Ground map operation is most effective over land and water masses. Any 20-mile wide band of the display can be expanded to fill the scope for more detailed viewing, by depressing the BCN & GROUND MAP EXPAND switch.

Beacon Display Operation.

Place operation switch (figure 4-25) at BEACON position. The scan characteristics of the equipment during beacon operation are the same as those for ground map except that the normal elevation position of the scan pattern is zero degrees. When a ground beacon station responds to interrogation by the fire control radar, a coded beacon indication in the form of short horizontal bars appears along the sweep trace. The position of the lowest bar along the vertical trace indicates the beacon range; the lateral displacement of the beacon response from the center of the screen indicates the beacon azimuth. The number of bars and the spacing between them indicates the coded pattern which identifies the beacon.

Beacon and Ground Map Expand Control.

When the system is in beacon or ground mapping operation, the expand knob (figure 4-25) is used to expand any 20-mile zone of the range sweep trace to cover the entire scope face. Thus, land mass patterns or beacon responses appear magnified and in greater detail. The expand control knob is subject to two types of adjustment. It is rotated to select the zone for expansion. It is then pressed inward (and held) to present the expanded display on the screen. When the knob is in the normal (undepressed) position, a strobe line appears on the 200-mile range sweep trace as a guide to zone selection. The position of the strobe indicates the lower limit of the expansible 20-mile zone. When the knob is in the maximum counterclockwise position, the strobe appears at zero range on the screen. If the control is depressed at this time, the scope indication will cover the range from 0 to 20 miles. With the knob in its maximum clockwise setting, the strobe appears at a position corresponding to 180 miles of range on the sweep trace. Depressing the expand control at this point will give a scope display of the range zone between 180 and 200 miles.

Reduced Power.

An automatic control provides overload safety for the high output power circuits of the equipment. Should arcing or other types of overloading occur, the system immediately goes into a condition of reduced power output, and the "Reduced Power" monitor lamp glows.

If this occurs while the system is in search operation, the radar observer should perform the following procedures:

1. Turn the master switch to STBY momentarily, then back to OPER.
2. If the "Reduced Power" lamp continues to glow, turn the master switch to STBY and set the operation switch to SHORT PULSE, then turn master switch back to OPER.
3. If the overload is still present, retune the transmitter frequency slightly by momentary pressure on the anti-jam button.
4. If none of the above procedures remove the overload, the system will continue to operate in short pulse mode under reduced power. Should the overload increase, however, certain power distribution circuits of the set will automatically be disconnected and no echoes will appear on the screen. In this event, throw the master switch to DISCONN and notify the pilot that radar operation is discontinued.

Turn-Off Procedure.

CAUTION

Turn off equipment 10 minutes prior to landing, or after airplane is parked, to allow gyros to cage. This prevents gyros from being damaged.

1. IF gain—Counterclockwise.
2. Search intensity—Counterclockwise.
3. Search—12,000 YDS.
4. Scale illumination—Counterclockwise.
5. Panel illumination—Counterclockwise.
6. Pressure switch—OFF.
7. EI scan—HOR.
8. Operation—SHORT PULSE.
9. Az scan—CENTER BOARD.
10. EI intensity—Counterclockwise.
11. Clutter eliminator—OUT.
12. Master switch—DISCONN.
13. If the equipment is to be secured, restore the indicator to its stowed position by firm pressure on the knobs of the unlatching bar. Test to see that the indicator is locked in the stowed position by applying moderate pressure against the indicator housing.

SIGHT.

Some airplanes have a standby modified N-9 sight located just forward of the instrument panel in the pilot's cockpit. A reticle image dimmer control and a

sight bulb switch operate the sight and on some airplanes in Groups 1 through 30 are located forward on the pilot's left console. On Group 35 and subsequent airplanes the sight bulb switch and reticle dimmer control are located on the armament control panel. The N-9 sight incorporates a reticle with a full 60-mil circle, a 2-mil dot in the center and two 60 degree segments of a 30-mil circle entered vertically. The standby N-9 sight is provided for use if the radar system becomes inoperative.

ARMAMENT.

The standard armament of this airplane consists of one hundred and four 2.75-inch FFAR rockets. Fifty-two rockets are carried in the forward section of each wing tip fuel and rocket pod (see figure 4-24). The rocket tubes are arranged in a cluster stacked in a honeycomb arrangement on the centerline of the pod and in a circle around the center cluster. For the circle of rockets there are spring-loaded muzzle doors at the nose cap of the pod which are automatically opened by the rockets as they are fired. Each muzzle door has its own electric heater, controlled by the master anti-ice switch, to prevent it from being jammed by ice. Each rocket in the center of the cluster has an expandable plastic plug covering the forward end of its launching tube. Rocket exhaust area is located around the periphery of the pod immediately aft of the rocket bay. The rockets may be fired manually by the pilot or automatically by the operation of the E-6 electronic rocket-firing control system. Rocket-firing phase may be set so that all rockets may be fired in one pass, two passes, or three passes at the target. In all cases, rocket firing is simultaneous and symmetrical from both wing tip pods.

ROCKET FIRING CONTROLS.

Control switches for the rocket firing system are on the armament control panel (figure 4-31), located on the pilot's center pedestal; a trigger is on the control stick grip, and one switch and indicator light are located on the pilot's aft miscellaneous panel (figure 4-30).

Safety Control Switch.

The safety control switch on the armament panel (figure 4-31) controls the electrical power necessary for firing-control system operation. Placing this switch in the ARM (ON) position energizes the 28-volt d-c electrical circuit, supplying power for the rocket-firing trigger, the rocket-firing selector switch, and the rocket-firing phase-selector switch. In the SAFE (OFF) position, the safety control switch breaks the electrical circuit and the firing-control system is in a safe condition. In addition to this switch, a landing gear safety switch is incorporated in the system to prevent inadvertent firing of the rockets while the weight of the airplane is on the landing gear.

Note

To prevent inadvertently firing the rockets in flight, the safety switch must be SAFE (OFF) at all times when rocket firing is not desired.

Intervalometer Reset Switch and Indicator Light.

An intervalometer reset switch and indicator light (figure 4-30) are located on the pilot's aft miscellaneous control panel outboard of the throttles. This switch is used to reset the intervalometer for firing the rockets in sequence during automatic and manual fire. The



Figure 4-30.

switch is springloaded in the normal position. Before operation of the rocket-firing control system, the reset switch should be held at RESET position until the reset indicator light comes on, indicating that the intervalometer is reset to keep the correct firing sequence.

Note

With one exception, do not operate this switch between passes of a two- and three-pass attack mission, as the firing sequence will be disrupted and "kill" probability will be reduced. The exception to this rule is discussed under Rocket-Firing Phase-Selector Switch.

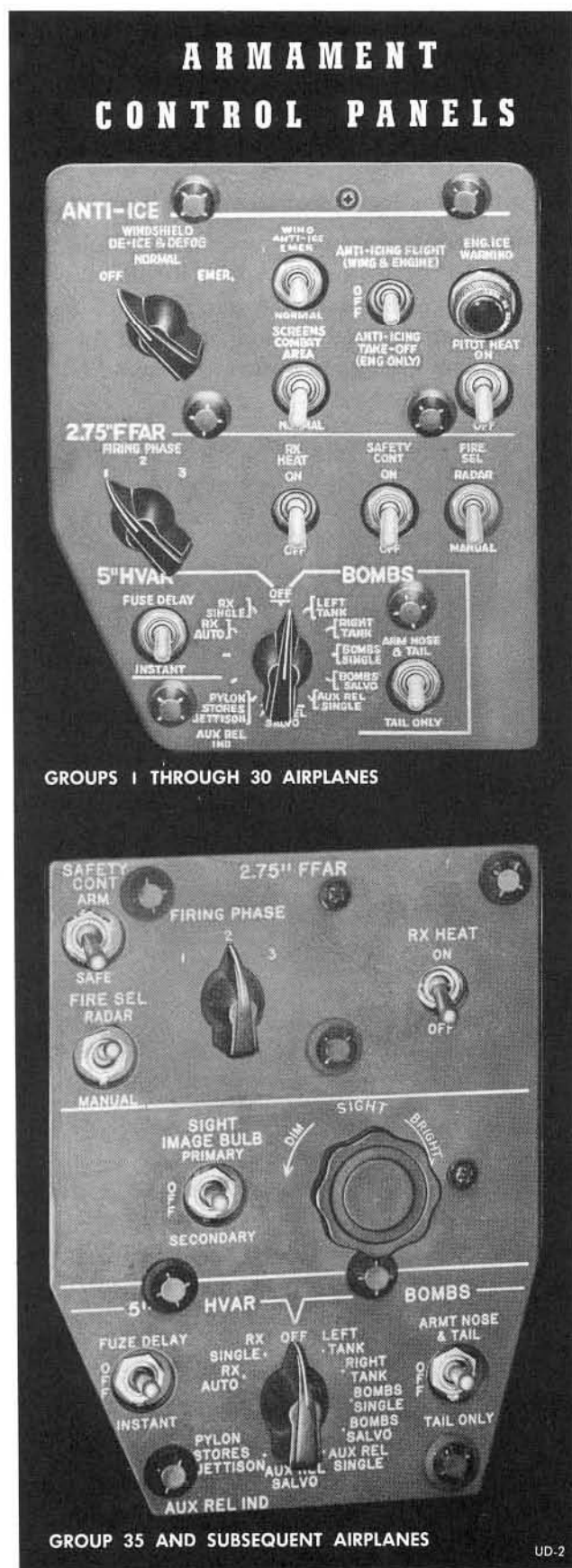


Figure 4-31.

Rocket-Firing Selector Switch.

The rocket-firing selector switch on the armament control panel (figure 4-31) has RADAR and MANUAL positions. With this switch the pilot can select either manual or radar-controlled firing of the rockets. With the selector switch at MANUAL, the rockets are fired when the rocket-firing trigger on the control stick grip is depressed. When the rocket-firing phase selector switch is set for more than one pass, trigger action is required for each pass made at the target. With the selector switch in the RADAR position and the rocket firing trigger depressed, the rocket-sighting radar impulses will fire the rockets when the course and speed of the airplane, the course and speed of the target, and the range to the target, combine to predict a direct hit. The radar impulses will not fire the rockets unless the rocket-firing trigger is depressed, nor will the rocket-firing trigger fire the rockets until the radar impulses are produced. The rocket-firing trigger must be depressed for each pass selected by the firing phase selector switch.

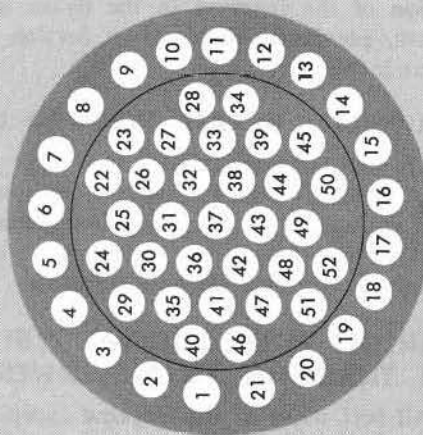
Rocket-Firing Phase-Selector Switch.

The rocket-firing phase-selector switch on the armament control panel (figure 4-31) permits firing rockets in any of three firing phases. The switch positions are 1, 2, and 3. A diagrammatic description of the firing phases is shown in figure 4-32. When the switch is placed at the 1 position, the firing control system allows all rockets to be fired in sequence during one pass at the target. Intervals between rocket firing are controlled by an intervalometer which produces firing impulses 50 milliseconds apart. For a one-pass attack, ten impulses are produced, firing all rockets in less than half a second. In the 2 position, on the first pass, six impulses are produced, firing the center cluster of rockets at the target; on the second pass, five impulses are produced, firing the remaining (outer ring) rockets. In the 3 position, on each of three passes, five impulses are produced. The first of these passes fires the outer ring rockets (in exactly the same sequence as the second pass of the position 2 selection). The next two passes fire the inner cluster rockets, approximately half the cluster at each pass. A situation may arise where after firing the first pass of a phase three selection, it is determined that only one more interception is possible. In this case it is desirable to fire all the remaining rockets on the next pass rather than only half, as would normally occur on the second pass of phase three. If phase three has been selected and the first pass made, the remaining rockets can be fired on the next pass by first holding the reset switch at RESET position until the indicator light comes on, then turning the phase selector knob to 2. This procedure permits the inner cluster (all remaining) rockets to be fired in the same sequence as though they had been fired on the first pass of phase two.

ROCKET FIRING SEQUENCE

PHASE

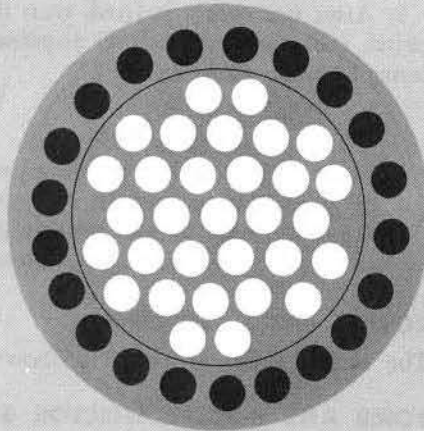
ONE



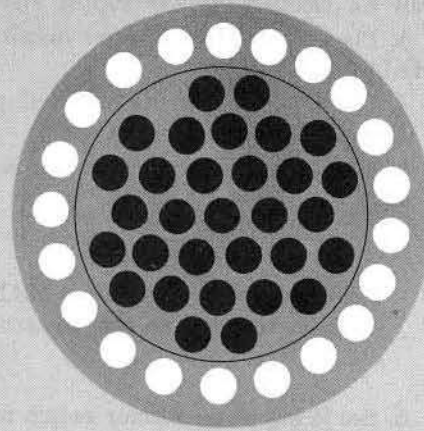
PASS ONE: TOTAL FIRED—52

PHASE

TWO



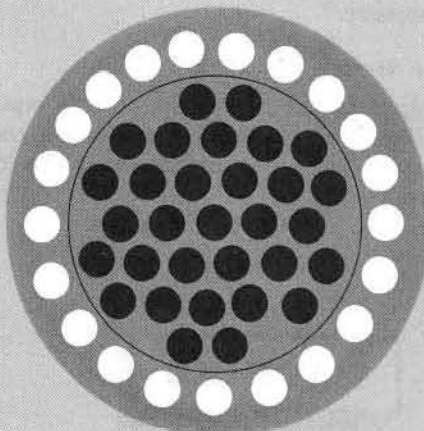
PASS ONE: TOTAL FIRED—31



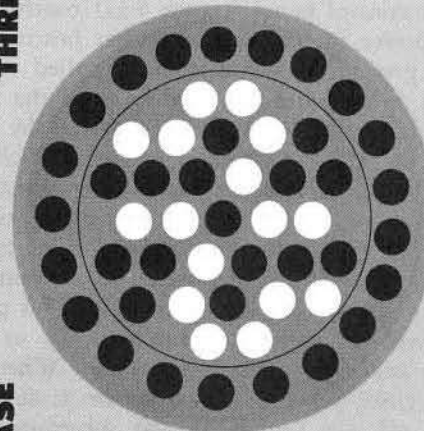
PASS TWO: TOTAL FIRED—21

PHASE

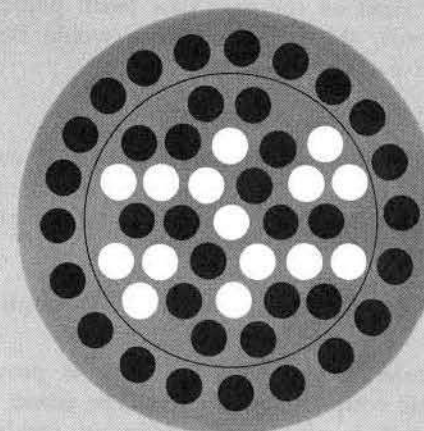
THREE



PASS ONE: TOTAL FIRED—21



PASS TWO: TOTAL FIRED—16



PASS THREE: TOTAL FIRED—15

Figure 4-32.

Note

After one pass of rockets has been fired with phase three selected, phase one should never be selected. Although all remaining rockets would be fired on the next pass (with phase one selected), the firing sequence would be less effective on the target.

Rocket Firing Trigger.

The rockets are fired when the fire selector switch is at MANUAL and the safety control switch is at ARM (ON), by depressing the rocket firing trigger (figure 1-30) on the control stick grip.

Rocket Heating Switch (Groups 1 Through 45 Airplanes).

Each rocket tube in the wing tip pods is provided with an electric wrap-around blanket. The center cluster in each pod is also wrapped in an insulating blanket. The purpose of the blankets is to keep the rockets at the temperature at which they are loaded in the airplane. The on-off rocket heating switch on the armament control panel (figure 4-31) controls the 115-volt a-c power to operate the rocket heating system. On the ground, power may be supplied to the rocket heaters to maintain temperature after the rockets are loaded or during an "alert" period by connecting both d-c and a-c external power and closing the external power switch on the alternator control panel. The temperature control rheostat, a part of the potentiometer located in the nose section, is set by the rocket loading personnel to correspond to the temperature of the rockets at the time of loading. This preset temperature will be maintained automatically as long as the rocket heating system is operating. When the last rocket is fired, the rocket heat system is automatically turned off. On Group 50 and subsequent airplanes, the rocket heating switch and all rocket heating equipment have been eliminated. Improved propellants have made the temperature control of rockets in the pods unnecessary.

Rocket Door Heater Control.

Each rocket door in the rocket tip pods is equipped with calrod heaters to prevent ice formation and ensure actuation of the door mechanism. The calrod heaters are controlled by the master anti-ice switch (figure 4-4) on the anti-ice control panel.

FIRING ROCKETS.**WARNING**

Firing of rockets with any amount of tip fuel is prohibited. This limitation is imposed to prevent overloading tip pod attachment fittings.

1. Before firing the first pass of rockets, make sure intervalometer has been reset. Hold reset switch at RESET and check to see that indicator light is on.

2. Check with radar observer to be sure that 115-volt a-c electrical power supply system is operating.

3. Place single-phase inverter switch at MAIN (NORMAL).

4. Check to see that rocket heating switch (Groups 1 through 45 airplanes) is at ON.

5. Place firing selector switch at RADAR or MANUAL.

Note

If firing selector switch is at MANUAL, radar observer will not be able to accomplish lock-on.

6. Set firing phase-selector switch to desired position.

7. Place safety control switch at ARM (ON).

8. Fire rockets by depressing trigger on the control stick grip.

9. After last rocket is fired, turn the rocket heating switch (Groups 1 through 45 airplanes) and the safety control switch to SAFE (OFF).

Note

In manual control, depressing the firing trigger fires the rockets. In radar control, both the radar impulses and depression of the trigger are required to fire the rockets.

ROCKET FIRING SEQUENCE.

The rocket firing sequence is shown in figure 4-32.

BOMB AND ROCKET SELECTOR SWITCHES.

Bomb and rocket selector switches (figure 4-31) are located on the lower portion of the armament control panel on the pilot's center pedestal. With the exception of the function in the pylon tanks jettison system, previously discussed in Section I, these switches are inoperative.

AUXILIARY RELEASE INDICATOR LIGHT.

An auxiliary release indicator light (figure 1-10), located on the pilot's center pedestal, indicates the status of the auxiliary underwing fragmentation bomb racks. When the light is on, the racks are cocked; when the light is off, the racks have released.

SINGLE-POINT FUELING SYSTEM (GROUPS 1 THROUGH 70 AIRPLANES).

All fuel tanks of the airplane except pylon tanks can be fueled through a single-point fitting aft of the right wheel well. Lines, valves, control switches, and indicator lights in addition to those needed for in-flight fuel management are included in the fuel system so that the airplane can be fueled quickly through

SINGLE-POINT FUELING SYSTEM

(GROUPS 1 THROUGH 70 AIRPLANES)

SINGLE-POINT FUELING FLOW

STATIC FUEL

VENT

ELECTRICAL ACTUATION

CHECK VALVE

BOOSTER PUMP

MOTOR-DRIVEN VALVE

BREAKAWAY CONNECTION

DUAL-DIAPHRAGM SHUTOFF VALVE

FLOW-ACTUATED SWITCH

PRESSURE-VACUUM RELIEF VALVE

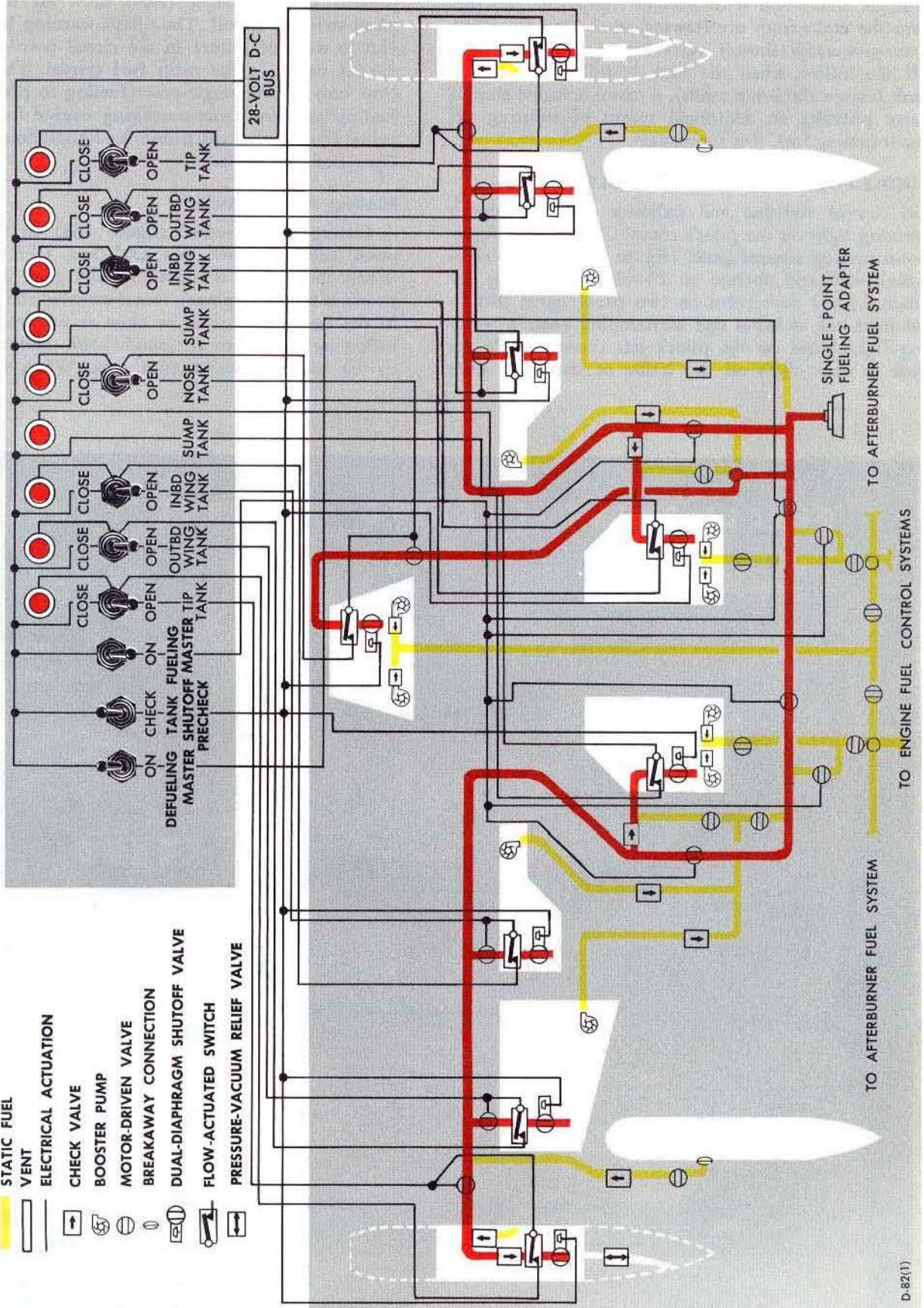


Figure 4-33.

D-82(1)

a single connection with ground equipment. To prevent the tanks from overflowing when they are filled, a servo-actuated shutoff valve inside each tank shuts off the inflow when the tank is full. Outside each tank (except the sump tanks), a motor-actuated shutoff valve provides an additional means of shutting off the incoming fuel. (See figure 4-33.)

SINGLE-POINT FUELING CONTROLS.

All control switches and indicator lights, except a warning light on the pilot's console, are on the single-point fueling control panel (figure 4-34) in the right wheel well, and operate on 28-volt dc. Opening the control panel door turns on two panel lights that illuminate the switches and surrounding area; a warning light burns on the pilot's left console while the door is open. Bars on the inside of the panel door

prevent it from being closed until all the fueling panel switches are off. The pilot's warning light serves also to warn of failure in the closed position of two shutoff valves in the main fuel system. These valves close only during single-point fueling to prevent high fueling pressures from damaging engine fuel components. (For further discussion see Single-Point Fueling Operation, this section.)

Fueling Master Switch.

A fueling master switch (figure 4-34) on the single-point fueling panel, has ON and OFF positions. When the switch is moved to ON (and 28-volt d-c power is on the airplane), motor-actuated shutoff valves in the fuel system open or close as required to route inflowing fuel from the single-point fueling adapter to the fueling lines of each tank. When the master

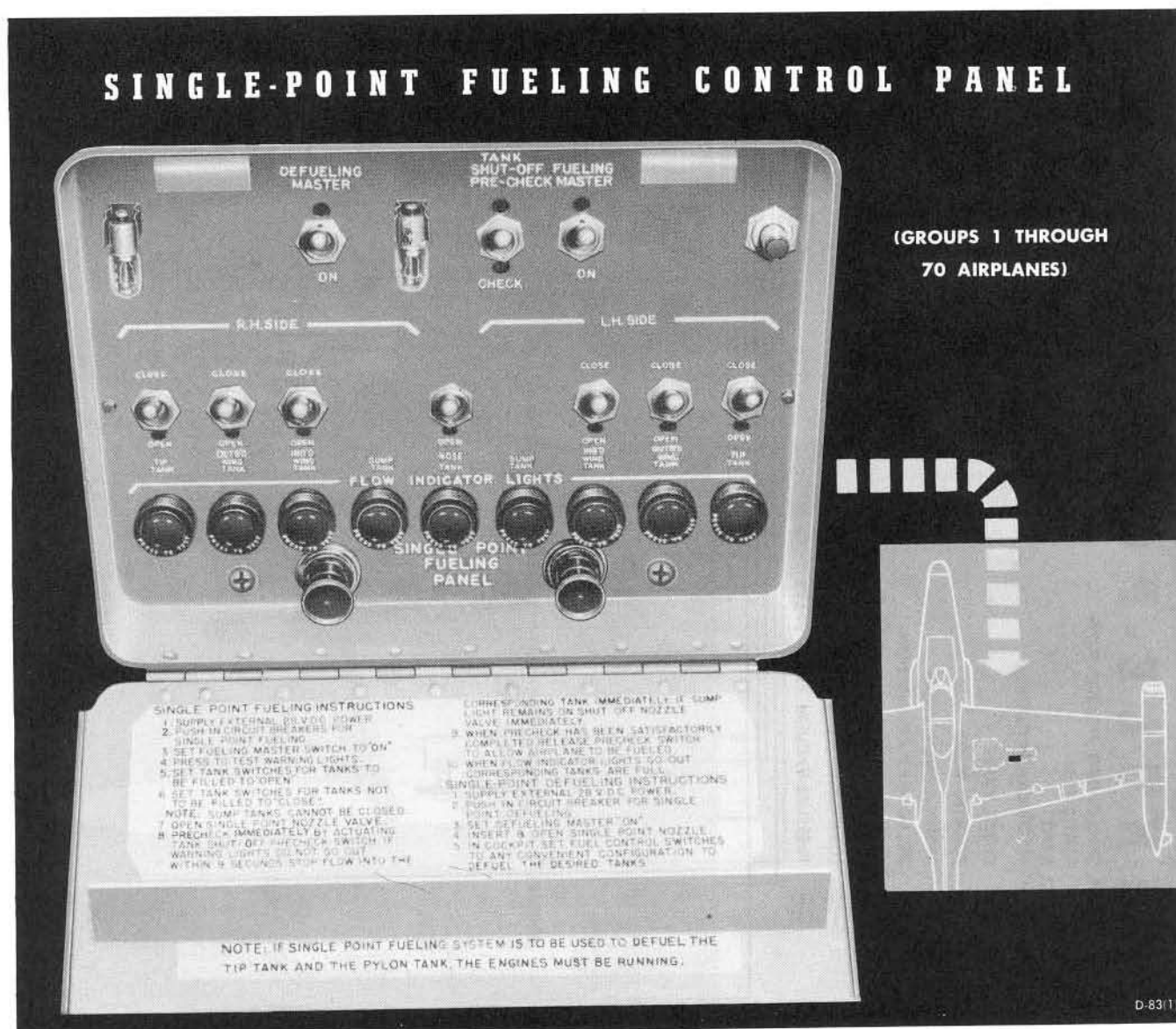


Figure 4-34.

switch is moved to OFF, the action of the shutoff valves is reversed.

Fueling Tank Switches.

Individual tank switches (figure 4-34) for all except the sump tanks are located on the single-point fueling control panel. These 28-volt d-c switches have OPEN and CLOSE positions; with the fueling master switch at ON, moving any of these tank switches to OPEN opens a motor-actuated shutoff valve in the fueling line to the corresponding tank. Moving the switch to CLOSE causes the valve to shut off flow into the tank.

Tank Shutoff Precheck Switch and Flow Indicator Light.

A 28-volt d-c switch (figure 4-34) on the single-point fueling control panel, spring-loaded to the OFF position and marked PRE-CHECK, is used to test the operation of the shutoff valves that protect each tank from over-filling. When the switch is held to CHECK, a full-tank condition is simulated in each fuel tank, and if the shutoff valve is functioning properly (with fueling master switch and tank switches at ON and fuel flowing into the tank), the tank flow indicator lights will go out in a few seconds as each shutoff valve closes. When all flow indicator lights are out, it is safe to continue fueling. A light remaining on more than 9 seconds after the precheck switch is held to CHECK indicates a failure of the dual-diaphragm shutoff valve, and the flow to that tank must be shut off by moving the corresponding tank switch to CLOSE. If a sump tank flow indicator light does not go out during precheck, fueling must be discontinued immediately as there is no switch-controlled shutoff valve in the line to the sump tank. If the fueling precheck is satisfactory (all flow indicator lights out) the precheck switch is released, and all flow indicator lights (except for full tanks) should come on and burn until the corresponding tanks are filled to the correct level. As each tank is filled, its light should go out, whereupon the operator should turn that tank switch off at once to forestall possible intermittent opening and closing of the tank's shutoff valve as the fuel level oscillates slightly within the tank. When all lights are out all tanks are filled.

Defueling Master Switch.

A defueling master switch (figure 4-34), operating on 28-volt dc and located on the single-point fueling control panel, provides a means for emptying the wing tanks, sump tanks, or nose tank through the single-point fueling adapter as a ground operation. This switch must be at ON for defueling and must be at OFF when the airplane is being fueled through the single-point system. To defuel the left wing tanks or the left sump tank, the crossfeed switch on the pilot's fuel control panel must also be at ON. The pylon tanks and the tip tanks can be defueled through the single-point system by using an external source of air to pressurize the tanks.

Note

Use of the single-point defueling system is normally in connection with a maintenance operation.

SINGLE-POINT FUELING OPERATION.

1. Supply 28-volt d-c external power.
2. Connect fueling nozzle to airplane's single-point fueling adapter, with fueling nozzle valve turned to OFF.
3. Circuit breakers for single-point fueling—Push IN.
4. Fueling master switch—ON.
5. All warning lights—Press to test.
6. Switches for tanks to be filled—OPEN.
7. Switches for tanks not to be filled—CLOSE.

Note

Sump tanks cannot be closed.

8. Single-point nozzle valve—OPEN.
9. Precheck switch—Hold immediately to CHECK.

CAUTION

- If warning lights do not go out within 9 seconds, stop flow into the corresponding tank immediately.
 - If sump light remains on, shut off nozzle valve immediately.
10. When precheck has been satisfactorily completed, release precheck switch to allow airplane to be fueled.
 11. When a flow indicator light goes out (corresponding tank is full), place tank switch at CLOSE.
 12. Fueling master switch—OFF; close panel door.

CAUTION

Do not take off with the single-point fueling equipment-out-of-position warning light burning on the pilot's left console, because the burning light indicates either that the single-point panel door is open and could interfere with the landing gear retraction; or that the door is closed but one or both valves that close during single-point fueling to protect the engine fuel components from high fueling pressures, have failed in the closed position. If this has occurred, the engine on the side of the closed shutoff valve cannot be fed through the crossfeed line, nor can fuel flow directly from the wing tanks to the engine on that side (fuel selector switch set at WING TANKS).

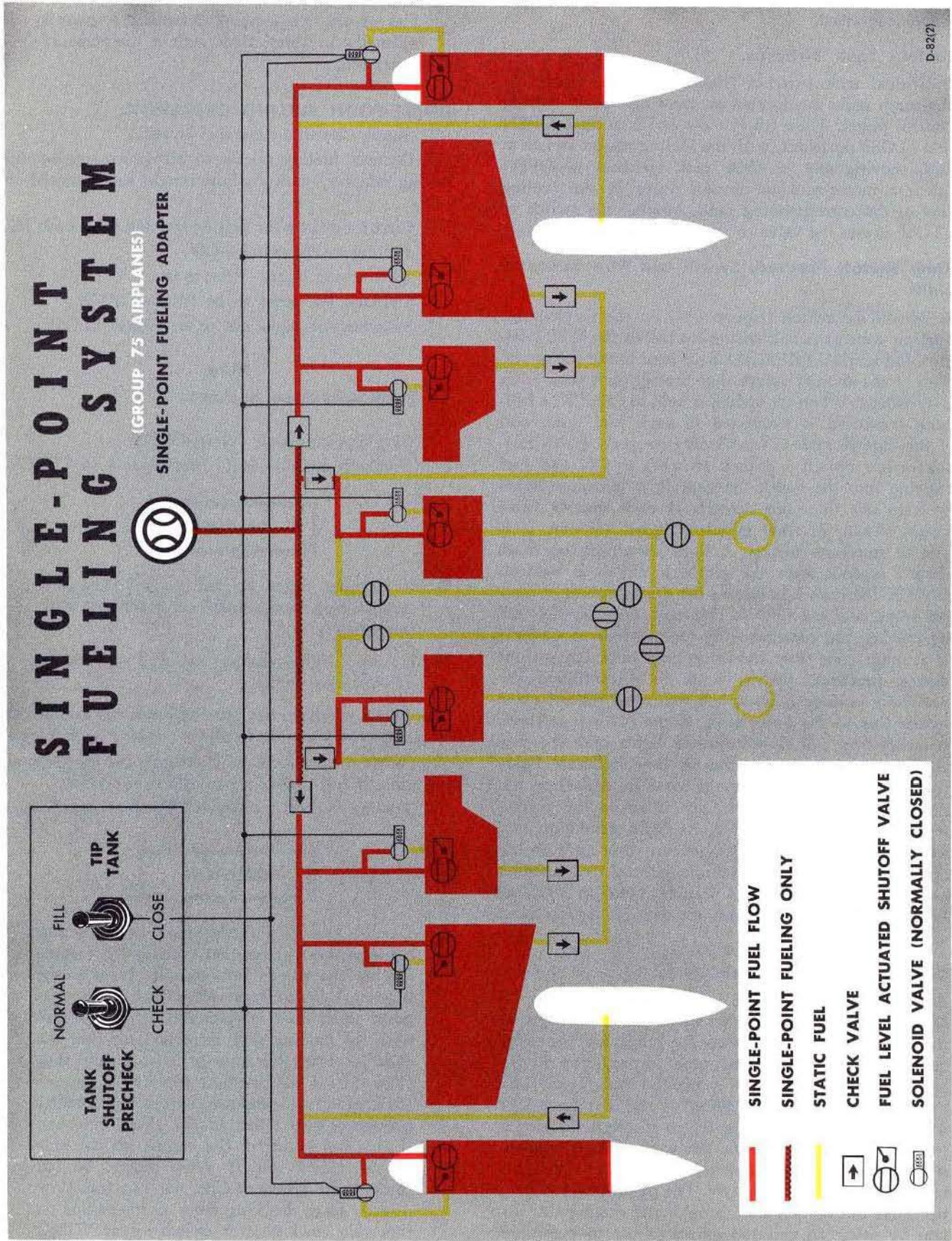


Figure 4-35.

CAUTION

If during the single-point fueling operation, fuel is forced out any of the tank vents under pressure, *immediately* turn fueling nozzle valve handle to OFF and investigate the cause of trouble.

DEFUELING OPERATION.

1. Connect 28-volt external power.
2. Circuit breaker for single-point defueling—Push IN.
3. Fuel selector switch and tank switches (on pilot's fuel control panel)—Set to tanks desired to empty. For example: to defuel a sump tank, set the corresponding selector switch to ALL TANKS and turn all tank switches on that side to OFF.
4. To defuel tanks in the left system, proceed as with the right system and turn the crossfeed switch to ON.

SINGLE-POINT FUELING SYSTEM (GROUP 75 AIRPLANES).

All fuel tanks except the pylon tanks can be fueled through a single high-pressure fitting located on the lower side of the right wing, aft of the wheel well. To prevent overflowing and to prevent high fueling pressure from entering the tanks, a fluid level actuated shutoff valve in each tank automatically closes as the tank becomes full.

SINGLE-POINT FUELING CONTROLS.

A 28-volt d-c tip tank control switch and a tank shutoff precheck switch (figure 4-36) are located in a switch box mounted in the right main landing gear wheel well. A 28-volt d-c circuit breaker located on the pilot's fuel control panel protects the single-point fueling system. The circuit breaker is left IN for all operation. The tip tank control switch has FILL and CLOSED positions. Placing the switch at FILL permits the tip tanks to fill during pressure fueling; placing the switch at CLOSE causes the tip tank shutoff valve to close and prevents fuel from entering the tip tanks during pressure fueling. The tank shutoff precheck switch has CHECK and NORMAL positions and is spring-loaded at NORMAL. Holding the switch at CHECK causes the tank shutoff valve in each tank to close under the same conditions that cause the valves to close when the tanks become full. While the precheck switch is held at CHECK, a rate of flow of approximately 40 gpm (noted on the single-point fueling equipment) indicates that all shutoff valves are functioning and that the system is safe for single-point fueling. Failure of any tank shutoff valve to close will be evidenced by a rate of flow in excess of 100 gpm, and pressure fueling must be

SINGLE-POINT FUELING CONTROL PANEL

(GROUP 75 AIRPLANES)

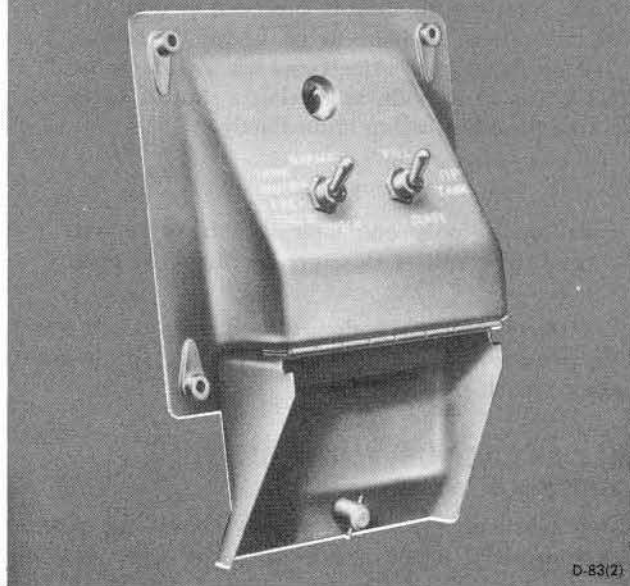


Figure 4-36.

stopped immediately. Releasing the tank shutoff precheck switch to NORMAL causes the tank shutoff valves to reopen and single-point fueling to continue. When the switch box cover is closed, the tip tank and tank shutoff precheck switches are automatically positioned for normal fuel system operation.

CAUTION

- Fuel selector switches must be at ALL TANKS or PUMPS OFF during single-point fueling. A WING TANKS selection will allow high fueling pressure to enter and damage low-pressure engine fuel components.
- Under no circumstances must pressure fueling be continued if a tank shutoff valve fails to close during prechecking. Failure of a shutoff valve to close during single-point fueling will result in structural damage and a serious fire hazard.

SINGLE-POINT FUELING OPERATION.

1. Apply 28-volt d-c external power.
2. Connect fueling nozzle to single-point fueling adapter.

3. Single-point refueling circuit breaker—IN.
4. Fuel selector switches—ALL TANKS if engines are operating; PUMPS OFF if engines are shut down.
5. Tip tank control switch—FILL or CLOSED, as desired.
6. Single-point fueling nozzle valve—OPEN; then immediately hold precheck switch at CHECK. If rate-of-flow does not exceed approximately 40 gpm after 12 seconds, release tank shutoff precheck switch to NORMAL and allow airplane to be fueled; if rate-of-flow is 100 or more gpm after precheck switch is held at CHECK for 12 seconds, indicating a shutoff valve failure, stop pressure fueling immediately.

Note

Failure of only one tank shutoff valve will result in a rate-of-flow greater than 100 gpm.

7. After airplane is fueled, turn fueling nozzle valve OFF, remove fueling nozzle, and close single-point fueling switch box door.

MISCELLANEOUS EQUIPMENT. WINDSHIELD WIPER.

The windshield wiper operates on 28-volt d-c power. The windshield wiper switch turns the wiper on and off, and has ON, OFF, and PARK positions. The switch is located adjacent to the speed rheostat (figure 1-9). The speed rheostat (figure 1-9) above the pilot's left console has INC and DEC positions for controlling the speed of the wiper motor. The speed rheostat must be at INC before the windshield wiper switch is turned to ON. If the wiper blade stops at an undesirable position when the switch is turned to OFF, the switch can be held momentarily to the spring-loaded PARK position; the blade will move to the right and stop automatically. If wiper blade stops and cannot be started with the speed rheostat, turn wiper off.

CAUTION

The speed rheostats should not be used to stop the wiper. Before either stopping or starting the wiper, the speed rheostat should be turned to INC.

RELIEF TUBES.

The relief tube for the pilot is on the floor to the right of his seat; one for the radar observer is to the right of his seat, aft of the wing spar.

MISCELLANEOUS PARTS STOWAGE.

Fuselage and wing jack pads, mooring fittings, and microphones are stored in two bags in the radio and equipment section in the aft fuselage. The ground

safety locks and the pitot tube covers are in a third bag near the floor to the left of the radar observer's seat.

MAP AND DATA CASES.

A data case and a flight report holder (figure 1-9) are beside the pilot's left console. A map data case (figure 4-8) is beside the right console in the radar observer's cockpit, and an airplane data case is in the aft radio and equipment section. On Group 25 and subsequent airplanes, two spring clips are located on the upper right surface of the pilot's glare shield to be used as required for temporary storage of maps, computer, flight plan, etc. while pilot is navigating.

CHECKLISTS.

Both the pilot and radar observer have a permanently installed metal checklist in their respective cockpits. The pilot's list (figure 1-10) slides out at the top of the center pedestal; the radar observer's list (figure 4-6) is above his instrument panel.

REAR VIEW MIRRORS.

A mirror on the left frame of the windshield enables the pilot to see rearward. A mirror on the right side of the canopy frame allows the pilot and radar observer to see each other.

EMERGENCY SIGNAL SYSTEM (GROUP 35 AND SUBSEQUENT AIRPLANES).

A red light and spring-loaded button-type switch in each cockpit provide a visual emergency system for the pilot and radar observer. In case of interphone failure or loss of the canopy, each crewmember can communicate with the other by means of code or prearranged signals. In the pilot's cockpit the button and signal light (figure 1-15) are mounted on a bracket directly below the right canopy defog duct. In the radar observer's cockpit the button (figure 4-8) is mounted on the inboard side of the right console and the signal light (figure 4-6) is located below the left side of the main instrument panel. The system is powered by the 28-volt primary bus.

BLIND FLYING CURTAIN ASSEMBLY.

Five orange acetate curtains can be snapped onto fasteners mounted in the pilot's cockpit to mask the windshield and forward canopy for simulated instrument flight. The curtains will not obstruct normal vision; but when the pilot wears blue goggles, he is unable to see through the curtains.

ANTI "G" SUIT EQUIPMENT.

The pilot's and radar observer's anti "G" suits are inflated by air pressure from the engine compressors. An anti "G" suit intake tube attaches to an air pressure outlet on the front of each seat. A pressure regulator valve (figures 1-9 and 4-7) on the left side of the seat is moved to LO and HI to control the pressure in the suit. Acceleration above 1.75 "G's" causes the valve to

open, inflating the anti "G" suit; for each additional "G" acceleration, the suit is inflated 1.0 psi (LO setting) or 1.5 psi (HI setting). A button on top of the valve can be pressed to inflate the suit momentarily.

Note

On Groups 1 through 45 airplanes the pilot's anti "G" suit equipment has been rendered inoperative.







OPERATING LIMITATIONS

DF-5

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Center-of-Gravity Limitations	5-12
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INTRODUCTION.

In addition to the operating limitations included in this section, cognizance must be taken of instrument markings, figure 5-1, since they represent limitations that are not necessarily repeated in the text.

MINIMUM CREW REQUIREMENTS.

The minimum crew is a pilot and radar observer or some other person familiar with emergency procedures. Because some circuit breakers essential to flight, the only alternate method of slow jettisoning the canopy, and the emergency hydraulic handpump are located in the rear cockpit, a radar observer or other qualified person must be present on all flights.

ENGINE LIMITATIONS.

STARTING.

During starting, the maximum allowable exhaust gas temperatures are 900°C on —47 engines and 910°C on —35 engines. Exhaust gas temperatures between

735°C and 900°C on —47 engines and between 750°C and 910°C on —35 engines are permissible for no more than 20 seconds. On afterburner starts, if the exhaust gas temperature momentarily exceeds 900°C on —47 engines or 910°C on —35 engines, or if 5 seconds after an afterburner start, the exhaust gas temperature exceeds 735°C on —47 engines or 750°C on —35 engines, stop the afterburner. Normal power is 95.6%; military power is 100% without afterburning; and maximum power is 100% with afterburning. There are no engine operating time limits.

WARNING

Some airplanes have J35—47 inner combustion liners installed on J35—35 engines. The cockpits of all airplanes so modified will be placarded and the lower J35—47 engine operating temperature limits must be observed.

AIRSPEED

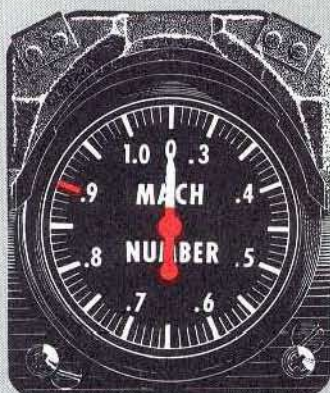
 195 KNOTS MAXIMUM FOR FULL FLAPS AND/OR LANDING GEAR DOWN

THE INSTRUMENT SETTING IS SUCH THAT THE RED POINTER WILL MOVE TO INDICATE THE LIMITING STRUCTURAL AIRSPEED OR THE AIRSPEED REPRESENTING THE LIMITING MACH NUMBER, WHICHEVER IS LESS.

 BELOW 20,000 FEET PRESSURE ALTITUDE, THE AIRSPEED LIMITATION IS 470 KNOTS IAS OR MACH 0.90, WHICHEVER IS LESS.



INSTRUMENT MARKINGS



MACHMETER

 BELOW 20,000 FEET PRESSURE ALTITUDE, THE AIRSPEED LIMITATION IS MACH 0.90 OR 470 KNOTS IAS, WHICHEVER IS LESS

ACCELEROMETER

 -2.33 "G's" MAX WITH EMPTY TIP AND PYLON TANKS

 -1.67 "G's" MAX WITH ANY AMOUNT OF TIP OR PYLON FUEL

 +3.67 "G's" MAX WITH ANY AMOUNT OF TIP OR PYLON FUEL



ENGINE TACHOMETER

-  80%—95% BEST CRUISING
 100% MAXIMUM



based on all fuel grades

EXHAUST TEMPERATURE**-35 ENGINES -47 ENGINES**

MINIMUM FOR FLIGHT
 CONTINUOUS OPERATION
 MAXIMUM FOR FLIGHT
 MAXIMUM DURING STARTING
 AND ACCELERATION ONLY

	315°C	315°C
	315°-680°C	315°-627°C
	750°C	735°C
	910°C	900°C

**OIL PRESSURE**

-  15 PSI MINIMUM FOR FLIGHT
 25—45 PSI CONTINUOUS OPERATION
 45 PSI MAXIMUM

**FUEL PRESSURE**

(GROUPS 1 THROUGH 30 AIRPLANES ONLY)

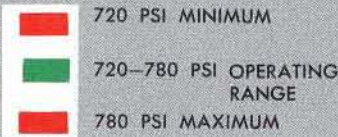
-  50 PSI MINIMUM FOR FLIGHT
 140—500 PSI CONTINUOUS OPERATION
 500 PSI MAXIMUM

D-84(2)

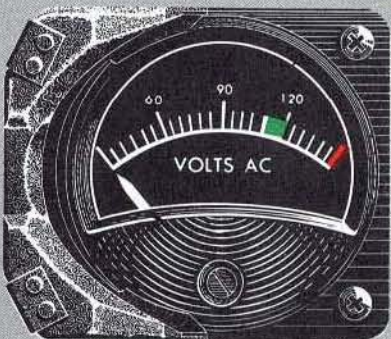
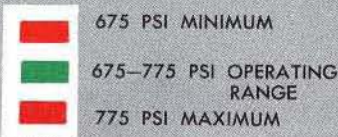
Figure 5-1 (Sheet 2 of 4 Sheets).



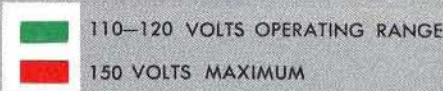
**NOSE GEAR BUNGEE
PRESSURE**



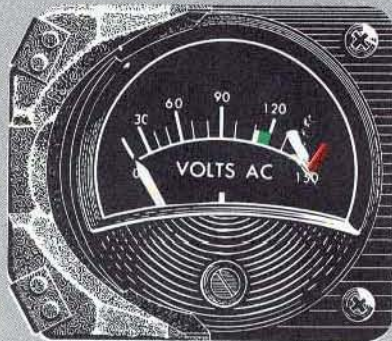
**MAIN GEAR BUNGEE
PRESSURE**



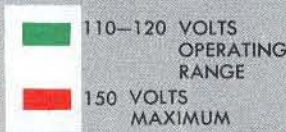
**VOLTmeter AC
ALTERNATOR**



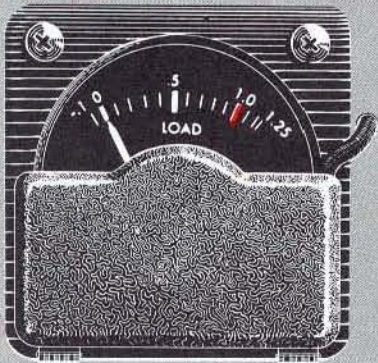
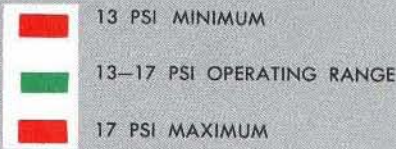
INSTRUMENT



VOLTmeter AC INVERTER



RADAR PRESSURE



LOADmeter 28-VOLT DC

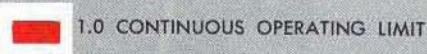
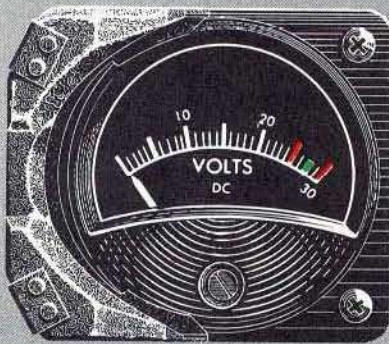
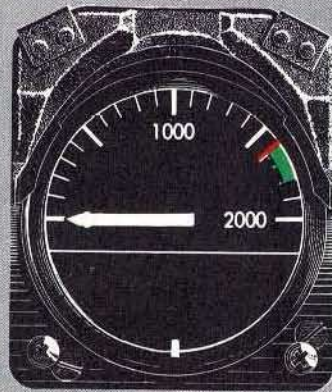
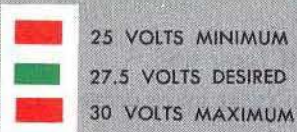
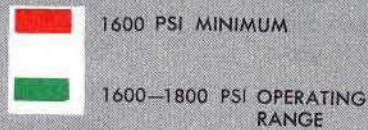
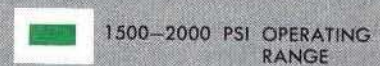


Figure 5-1 (Sheet 3 of 4 Sheets).

**VOLTMETER DC****PILOT'S SEAT PRESSURE GAGE****CANOPY EJECTOR PRESSURE**

MARKINGS

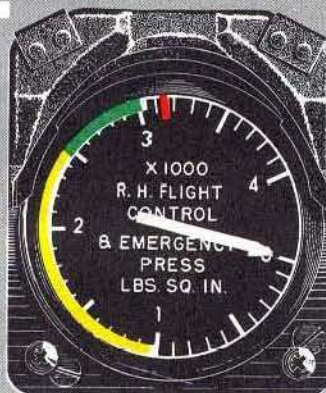
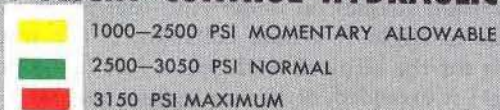
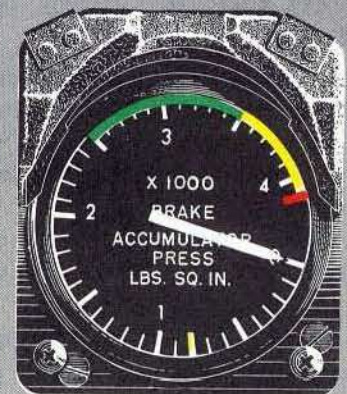
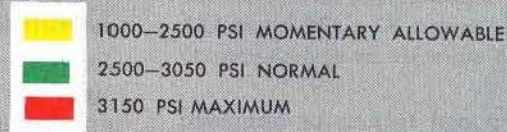
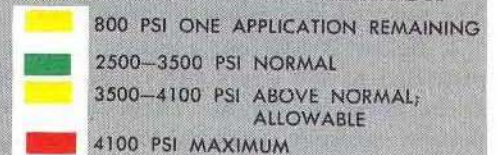
**LEFT FLIGHT CONTROL HYDRAULIC SYSTEM****RIGHT FLIGHT CONTROL HYDRAULIC SYSTEM****BRAKE ACCUMULATOR**

Figure 5-1 (Sheet 4 of 4 Sheets).

ACCELERATION.

During accelerations, the momentary exhaust gas temperatures are not to exceed 900°C on —47 engines, or 910°C on —35 engines except that peak temperatures between 900°C and 925°C on —47 engines and between 910°C and 940°C on —35 engines are permitted for a maximum of 3 seconds at engine speeds below 75% rpm. Temperatures between 735°C and 900°C on —47 engines and between 750°C and 910°C on —35 engines are permissible for no more than 20 seconds. Engine must be removed for overhaul if speed momentarily exceeds 104% rpm.

WARNING

Engine speeds greater than 103% rpm are prohibited and engine must be removed for overhaul if this rpm is exceeded under stabilized conditions or if 104% rpm is exceeded momentarily. Have the throttle reset if stabilized engine speed exceeds 102% rpm.

ALTERNATE FUEL LIMITATIONS (GROUP 75 AIRPLANES).

If MIL-F-5572 aviation gasoline is used as an alternate fuel, the following limitations must be observed:

1. With ambient temperatures of 0°F (–18°C) and lower, do not exceed Mach 0.4 below 5000 feet with afterburners operating.
2. With sea level ambient temperatures exceeding 70°F (21°C), do not exceed 25,000-foot altitude.

These limitations are to prevent cavitation of the engine-driven and booster pumps. On earlier airplanes, the pump pressures are sufficient to prevent cavitation.

AIRSPPEED LIMITATIONS.

The airspeed limitations are as follows:

1. Below 20,000-foot pressure altitude, airspeed is restricted to 470 knots IAS or Mach 0.90, whichever is the lower indication. These limits are imposed to prevent excessive structural loads resulting from gusts. The limits also reduce the hazard of reduced elevator control at high airspeed (especially in dives) in the 5000 to 20,000-foot altitude range. The 470 knots IAS and Mach 0.90 restrictions coincide at approximately 13,000-foot pressure altitude.
2. With less than all tip pod rockets or approved dummy rockets, do not exceed Mach 0.65 at any altitude until all tip tank fuel is gone. (See Center-of-Gravity Limitations, this section.)
3. With less than all tip pod rockets or approved dummy rockets, and with less than 400 pounds of fuel in the nose tank and all other tanks empty, do not exceed Mach 0.65 at any altitude. (See Center-of-Gravity Limitations, this section.)

4. With the exception of the limitations in items 2 and 3, airspeed is unrestricted above 20,000-foot pressure altitude.

Note

Cruising at Mach 0.65 instead of the airspeeds recommended in the appendix has negligible effect on range.

AUTOPILOT LIMITATIONS.

Autopilot-controlled flight below 25,000-foot pressure altitude is limited to 425 knots or Mach 0.78, whichever is less; however, the Mach 0.65 limitations described in the preceding paragraph must be observed.

WING FLAP LIMITATIONS.

Do not exceed the following structural limit airspeed of the wing flaps, or the wing flaps may fail structurally:

<i>Wing Flap Positions</i>	<i>IAS—Knots</i>
Wing flaps at takeoff (gear up)	230
Wing flaps full down (gear up or down)	195
Wing flaps down 7 1/2 degrees	285

Note

A wing flaps full down and 195 knots IAS condition can occur only when the airplane is accelerated to 195 knots IAS after extending the flaps. Airloads prevent fully extending the flaps at this airspeed.

LANDING GEAR LIMITATION.

With the wing flaps in any position, the structural limit airspeed of the landing gear is 195 knots IAS.

TIRE LIMITATION.

Speed on the ground should not exceed 140 knots at takeoff or 122 knots at landing to obtain normal tire life. Exceeding these speeds on occasion will not necessarily result in tire failure; however, continual operation at excessive ground roll speeds will result in reduced tire life and premature failure. For tire pressure see figure 5-2.

LANDING LIGHT LIMITATION.

Do not extend landing light above 175 knots IAS. The light was designed for use only during final approach and landing. If this limitation is exceeded, the landing light may fail structurally.

PYLON LIMITATIONS.

Overlimit stresses on underwing fuel pylon racks may occur in flight if a tank collapses, if the acceleration limit for the airplane with pylon fuel (1000 pounds or more) is exceeded, or if the airplane exceeds a roll rate of 90 degrees per second with 1000 pounds or more of

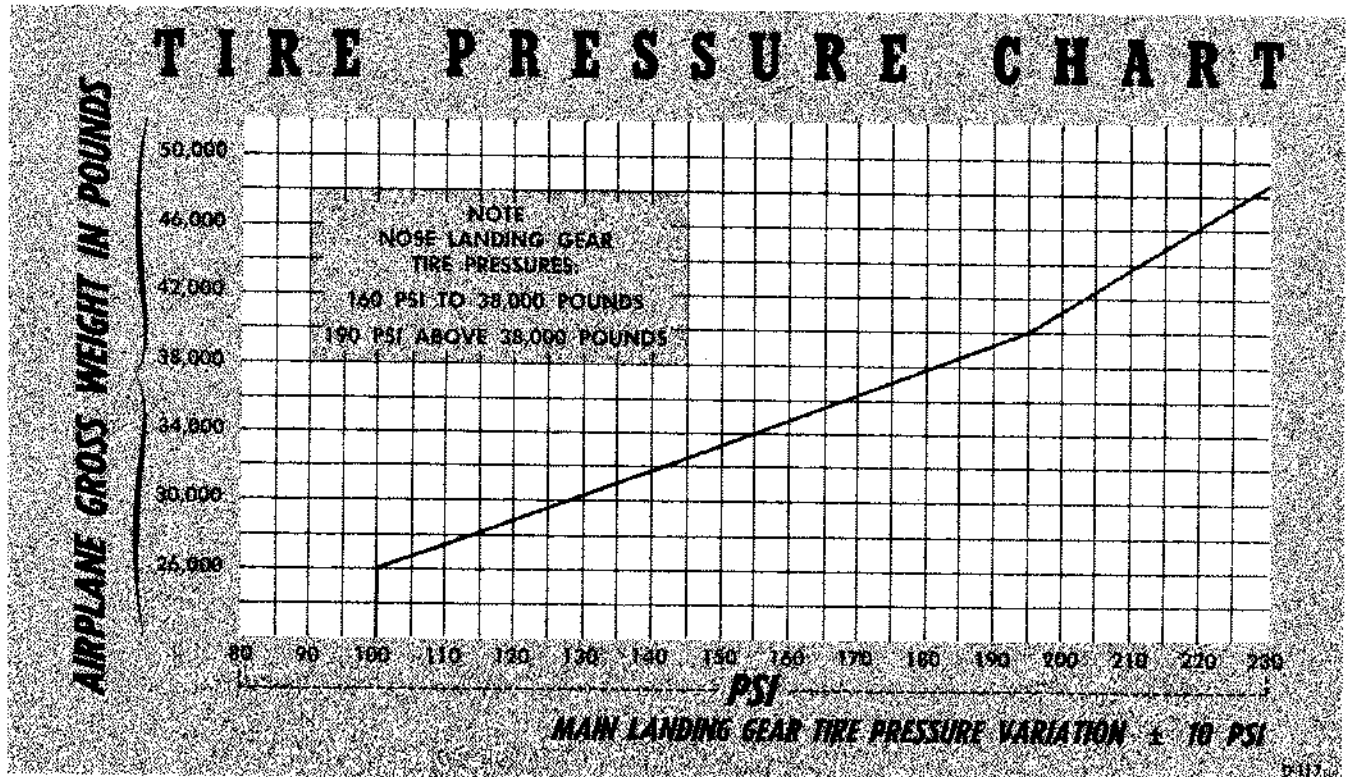


Figure 5-2.

pylon fuel. Landing with pylon tank fuel is prohibited. Rough taxiing with pylon fuel aboard should be noted on DD Form 781.

PYLON TANK JETTISON LIMITATIONS.

The following airspeed limitations will apply when jettisoning pylon tanks:

1. When using forced ejection procedure, do not exceed 300 knots IAS.
2. When releasing tanks to fall by gravity, fly the airplane as near as possible to 200 knots IAS.

CAUTION

- When the pylon tanks are jettisoned either manually or electrically (gravity drop), minor damage to the airplane may result.
- To prevent damage to the speed brakes, it is recommended that they be closed when jettisoning the pylon tanks.

Releasing the tanks at airspeeds substantially above or below 200 knots IAS, or ejecting them at airspeeds above 300 knots IAS may cause the tanks to tumble and strike the airplane.

CANOPY LIMITATIONS.

On Groups 1 through 20 airplanes, when the canopy is within 10 to 12 inches of being closed, it is free on the tracks and is held on the airplane only by its weight. Therefore, the canopy must not be opened during taxiing or flight as it may be jarred or blown from the airplane. On Group 25 and subsequent airplanes, the canopy track retains the canopy in all positions, and speeds up to 50 knots IAS are permitted while taxiing with the canopy open.

PROHIBITED MANEUVERS.

SPINS.

Intentional spins, with or without external stores, are prohibited.

ACROBATICS.

Acrobatics will not be performed below 12,000 feet.

INVERTED FLIGHT.

Inverted flight without afterburning can be maintained for approximately 8 seconds at 20,000-foot pressure altitude, as the only fuel available to the engines is the fuel in the lines and fuel controller. At lower altitudes, this time will be reduced because of increased fuel consumption.

how to use charts...

- 1** SELECT an INDICATED AIRSPEED.
- 2** MOVE UP THE CHART to a SELECTED ALTITUDE (SOLID or BROKEN LINE).
- 3** MOVE to the LEFT to the MAXIMUM NUMBER of "G's" YOU CAN PULL at that AIRSPEED and ALTITUDE.

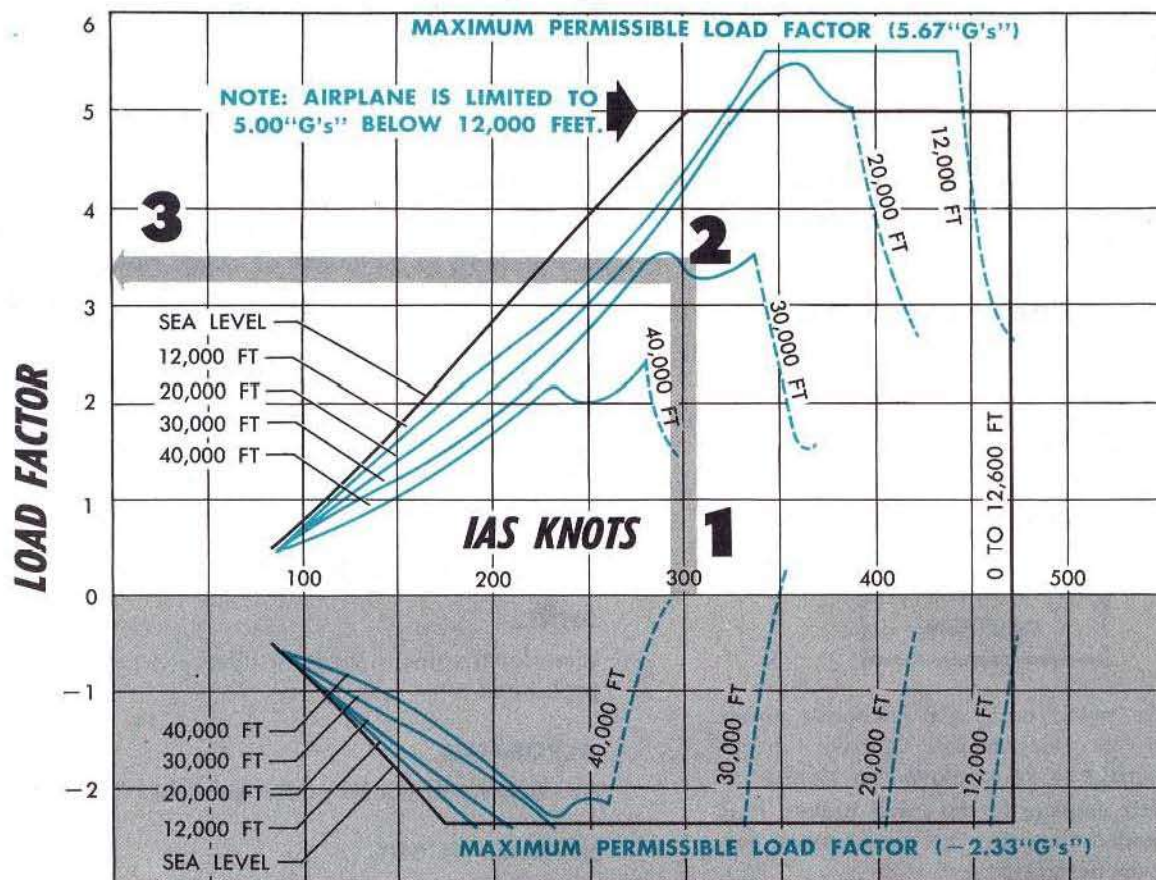
SOLID LINES REPRESENT
STALL LIMIT

BROKEN LINES REPRESENT
ELEVATOR CONTROL
POWER LIMITS

NO INTERNAL FUEL
NO TIP POD FUEL
NO PYLON TANKS
FULL TIP POD ROCKETS

For symmetrical flight
in smooth air

OPERATING FLIGHT STRENGTH DIAGRAM



30,700 Pounds Gross Weight

DATA AS OF: 15 MARCH 56
DATA BASIS: FLIGHT TEST

D-88(1)

Figure 5-3 (Sheet 1 of 3 Sheets).

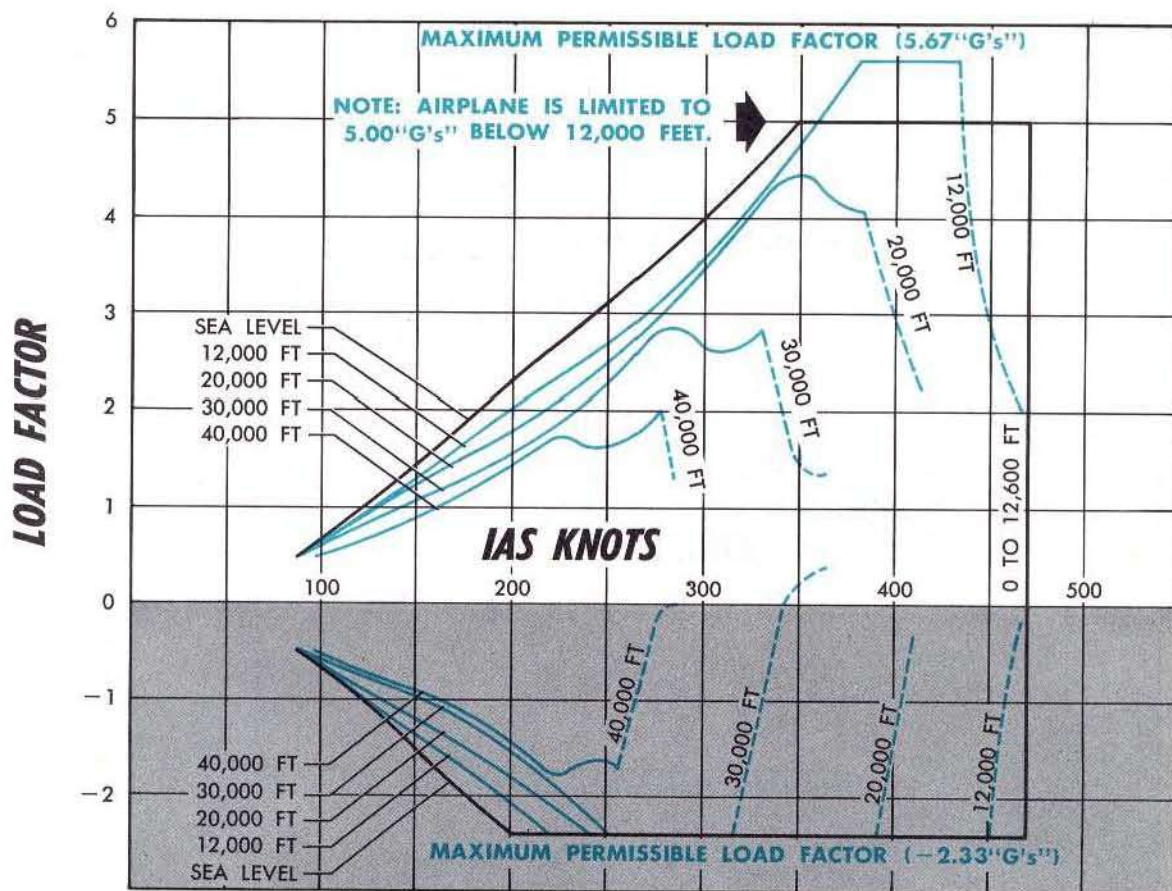
NO TIP POD FUEL
NO PYLON TANKS
FULL TIP POD ROCKETS

SOLID LINES REPRESENT
STALL LIMIT

BROKEN LINES REPRESENT
ELEVATOR CONTROL
POWER LIMITS

For symmetrical flight in smooth air

OPERATING FLIGHT STRENGTH DIAGRAM



38,300 Pounds Gross Weight

DATA AS OF: 15 MARCH 56
DATA BASIS: FLIGHT TEST

D-88(2)

Figure 5-3 (Sheet 2 of 3 Sheets).

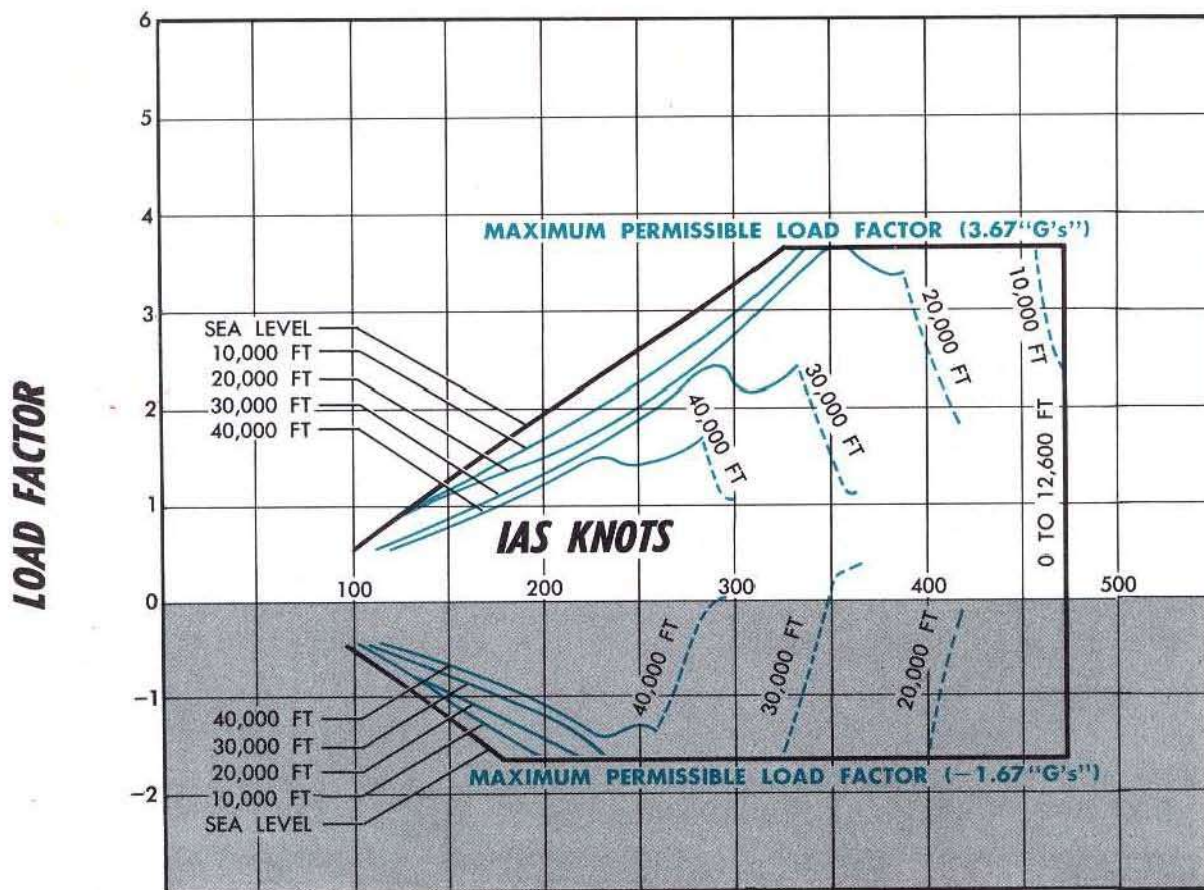
FULL INTERNAL FUEL
FULL TIP POD FUEL
FULL PYLON TANKS
FULL TIP POD ROCKETS

SOLID LINES REPRESENT
STALL LIMIT

BROKEN LINES REPRESENT
ELEVATOR CONTROL
POWER LIMITS

For symmetrical flight in smooth air

OPERATING FLIGHT STRENGTH DIAGRAM



46,700 Pounds Gross Weight

DATA AS OF: 15 MARCH 56
DATA BASIS: FLIGHT TEST

D-88(3)

Figure 5-3 (Sheet 3 of 3 Sheets).

Note

Inverted flight (and any maneuver involving negative "G" forces) with maximum power will result in immediate afterburner flameout.

LANDING.

Landing with any available tip tank or pylon tank fuel is prohibited, and caution should be exercised when landing with any rockets aboard. Landings at heavier than normal loading weight should be made with caution. Normal landing weight is one-half or less of internal fuel and no tip pod armament. These limitations are imposed to avoid overstressing the pod attachment fittings.

EMERGENCY FLIGHT CONTROL POWER.

On airplanes not equipped with left hydraulic system supplemental pump, when using emergency flight control power, only normal flight attitudes are permitted. Hydraulic pressure from the emergency flight pump is lower than normal pressure, and control surface movement and rate of movement for corresponding stick force is less than normal, and decreases with increasing airspeed.

ROCKET FIRING.

Firing of rockets with any amount of tip fuel is prohibited. This limitation is imposed to prevent overloading tip pod attachment fittings.

AILERON AND RUDDER MOVEMENT.

The following restrictions to aileron and rudder movement apply except during takeoff and landing:

1. With any available pylon or tip tank fuel, do not exceed one-third full aileron deflection.

Note

With no tip tank fuel and no pylon fuel (with or without empty pylon tanks), aileron deflection is unrestricted.

2. When pylon tanks (empty or full) are carried, or when carrying any tip tank fuel, abrupt rudder deflections are prohibited.

Note

Without pylon tanks or tip tank fuel, rudder deflection is unrestricted, except for fish-tailing maneuvers.

ACCELERATION LIMITATIONS.

A load factor envelope shown on the Operating Flight Strength Diagram (figure 5-3), includes the operating gross weight and operating altitude ranges

of the airplane. Lines on the left of the charts represent maximum lift limitations; top and bottom lines specify structural limit load factor; lines on the right indicate limit airspeeds and elevator control boundaries. The elevator control boundary lines show the necessity for careful regulation of airspeed during dive maneuvers because a small increase in IAS will result in a noticeable decrease in available load factor or ability to maneuver. This effect will be dangerous during dives at low altitude and prolonged dives from high altitudes where IAS can increase considerably above the maximum level flight airspeed. With *any* number of tip pod rockets, *no* tip tank fuel, and *no* pylon tank fuel, *do not* exceed the following load factors:

Note

Number of rockets carried has no effect on acceleration limits.

Above 12,000 Feet

Symmetrical	
maneuvering flight	+5.67 or -2.33 "G's"
Asymmetrical	
maneuvering flight	+3.78 or -1.00 "G"

Below 12,000 Feet

Symmetrical	
maneuvering flight	+5.00 or -2.00 "G's"
Asymmetrical	
maneuvering flight	+3.33 or -1.00 "G"

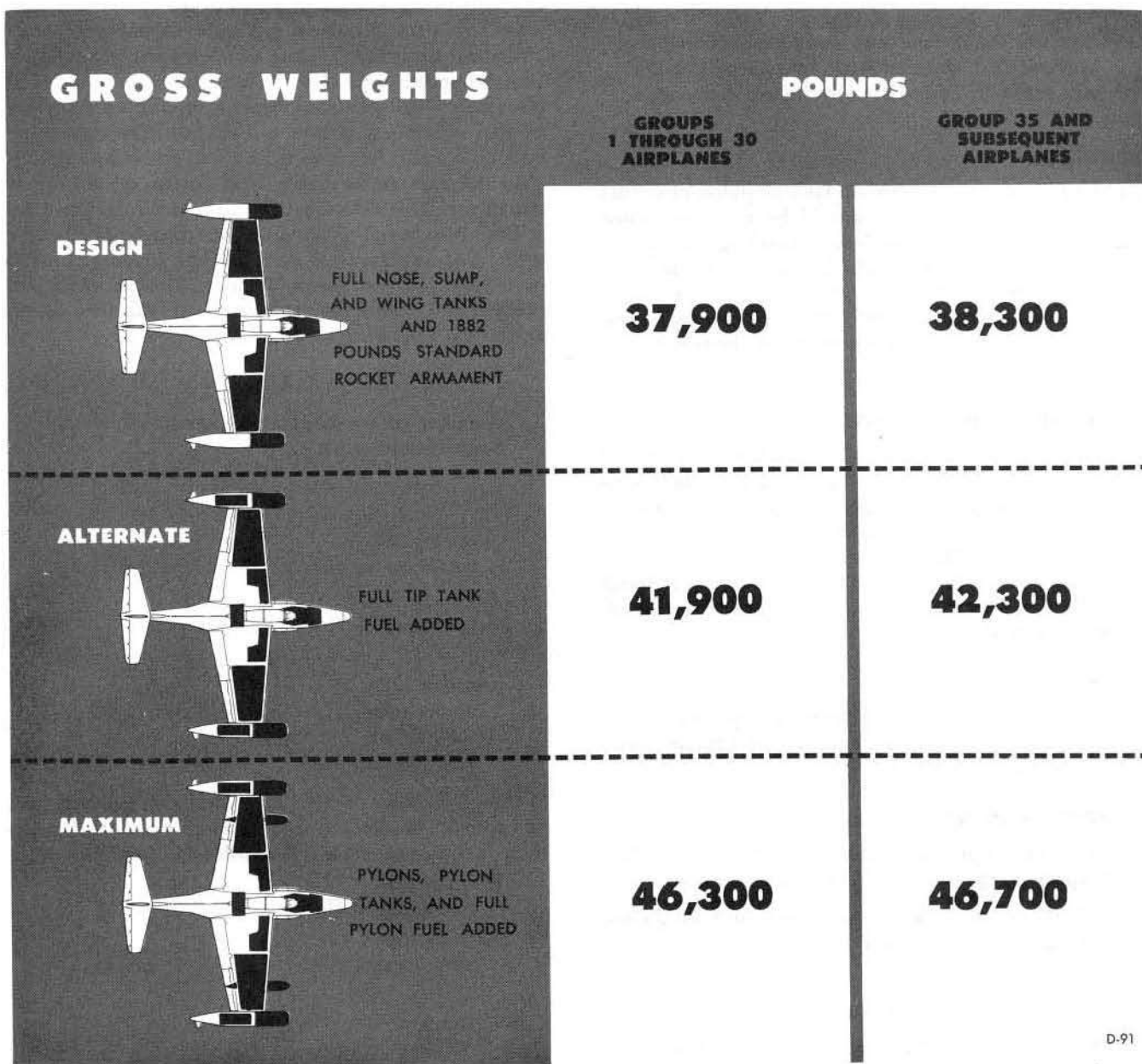
With *any* number of tip pod rockets, full internal fuel, *any* amount of tip tank fuel, and *any* amount of pylon tank fuel, *do not* exceed the following load factors:

Symmetrical	
maneuvering flight	+3.67 or -1.67 "G's"
Asymmetrical	
maneuvering flight	+2.45 or -1.00 "G"

Note

- Asymmetrical maneuvers are those which create unequal airloads resulting from aileron or rudder deflection. A coordinated turn, however, is a symmetrical maneuver once bank angle is established.
- Above the maximum level flight airspeed, the maximum *allowable* negative load factor reduces as airspeed increases, reaching -1.00 "G" at maximum airspeed attainable.

It is possible to overstress the tip tank attachment fittings and the pylon racks if a landing is made with fuel in these tanks; therefore, tip tanks must be emptied and pylon tanks must be emptied or jettisoned before landing. Not all of the tip tank fuel can be dumped during dives or deceleration because the fuel will shift and uncover the dump tube before the tank is emptied.



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Figure 5-4.

WARNING

- With *any* amount of tip fuel or pylon fuel at *any* altitude, *with* or *without* rockets, do not exceed +3 "G's" or -1.5 "G's."
- With empty pylon tanks and empty tip tanks, *with* or *without* rockets, avoid abrupt yawing maneuvers and do not exceed +4.5 "G's" or -1.5 "G's."

- Because of fire hazard, do not fire armament while tip tank fuel is being dumped.
- If airplane is trimmed for high speed flight at low altitude, airplane will nose down sharply if speed is reduced.

CENTER-OF-GRAVITY LIMITATIONS.

The forward cg limit is at 21 percent of the mean aerodynamic chord at 33,000 pounds gross weight or less, and 24 percent MAC at 48,000 pounds gross weight, varying linearly between these points. The

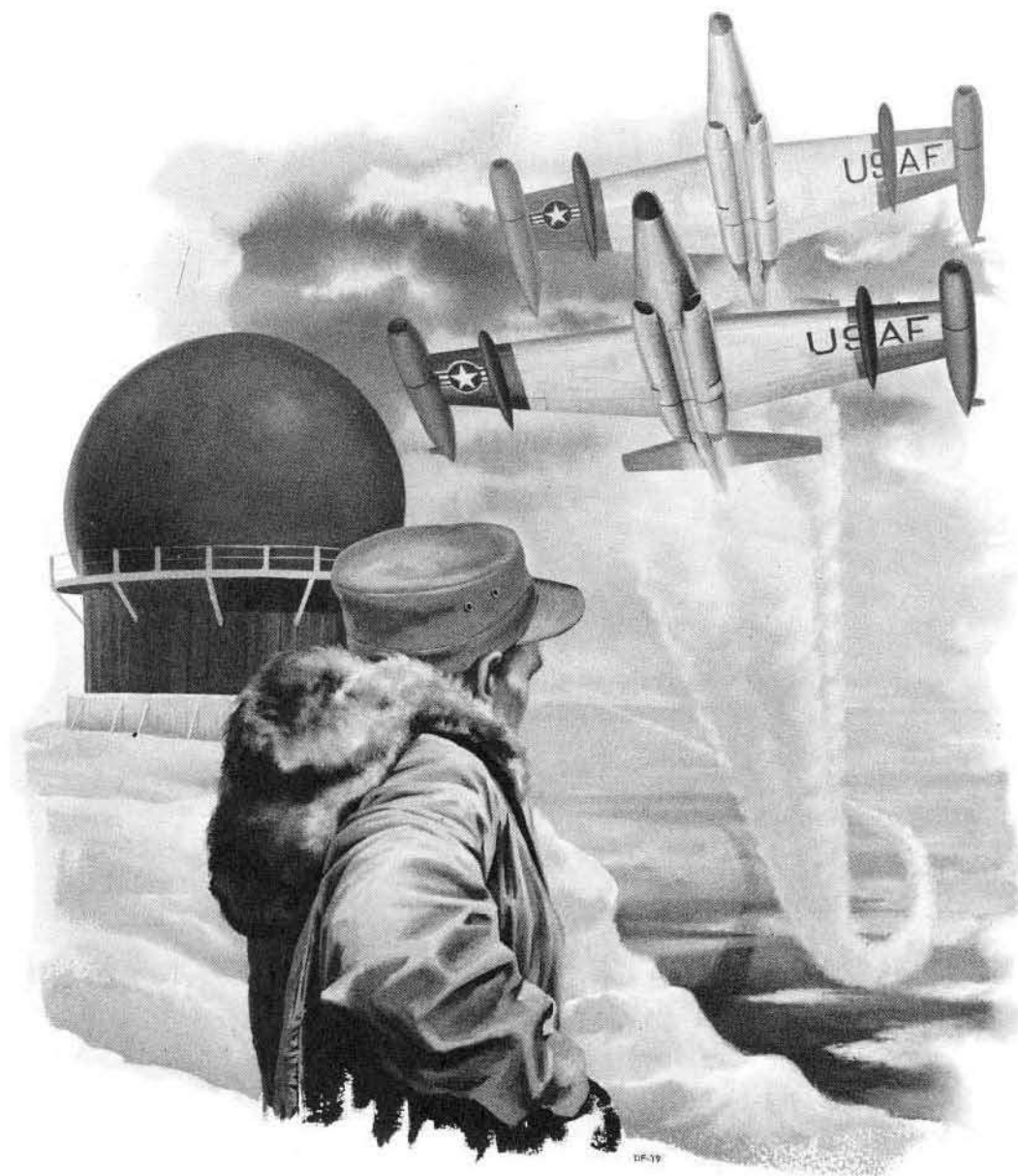
normal operating aft limit is 26.3 percent MAC at 48,000 pounds gross weight; and 28.3 percent MAC at 28,000 pounds gross weight; this limit varies linearly with gross weight. It is allowable for the aft cg limit to move 1.75 percent MAC aft of its normal position provided that airspeed does not exceed Mach 0.65. This condition is encountered when flying with less than all rockets (live or approved dummy) in the tip pods and with any amount of tip fuel, or

less than 400 pounds of fuel in the nose tank. For detailed instructions of weight and balance refer to T.O. 1-B-40 and T.O. 1F-89D-5.

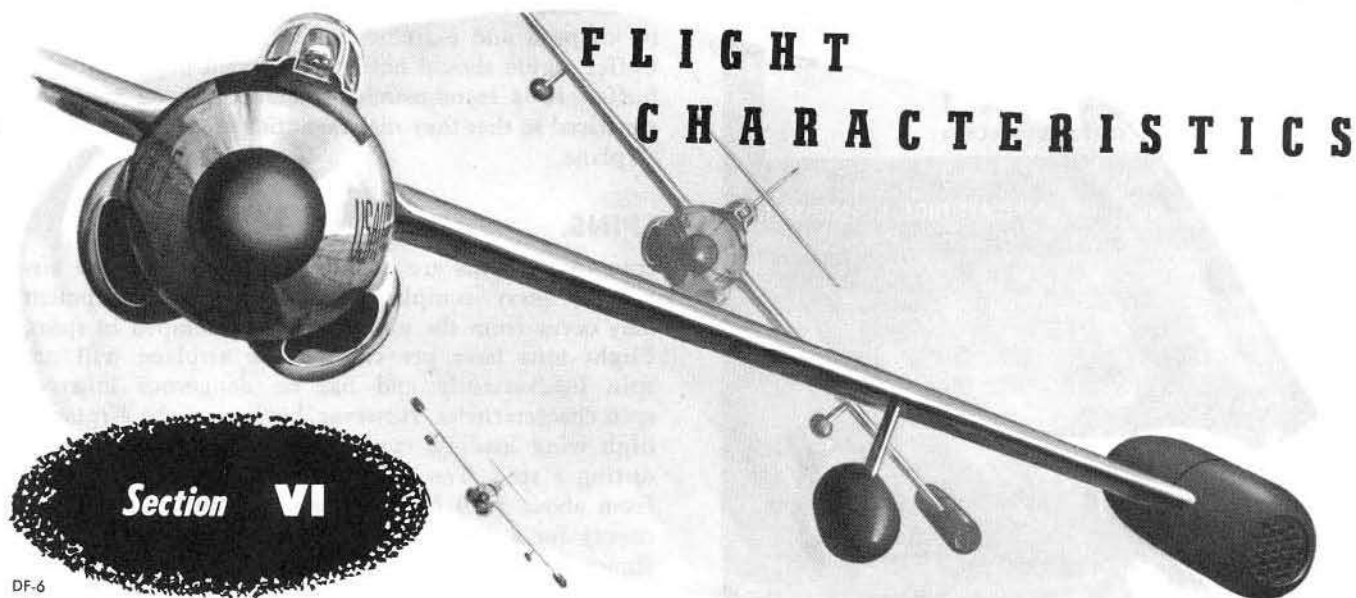
WEIGHT LIMITATIONS.

There are no weight limitations. See figure 5-4 for design, alternate, and maximum gross weights.





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DF-6

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INTRODUCTION.

The airplane is a large, high speed, fast-climbing, all-weather interceptor. The two-engine design increases dependability and permits high performance while carrying the heavy load of armament and equipment necessary for an intercept mission. All flight control surfaces are 100 percent hydraulically actuated. Full powered controls permit accurate control of the airplane at airspeeds which would otherwise make control forces prohibitively high. They also prevent sudden airload changes on control surfaces from affecting the stick or rudder pedals. The wide range of speed control possible with split-aileron speed brakes increases combat effectiveness. The sideslip stability augments provides satisfactory damping of the high speed Dutch Roll, assists the pilot in making coordinated turns in combat maneuvers, and provides a stable firing platform at high speeds. Tip pod fins, in addition to decreasing wing twist and keeping the center of spanwise lift more nearly constant, add to the longitudinal stability and control characteristics of the airplane. The fins increase the stick force per

"G" in the airspeed range where maneuvering stability is critical (from approximately 0.70 to 0.80 Mach number). The elevator control for the airplane with tip tank fins is less sensitive (a higher stick force is required to pull a given load factor), particularly for the aft cg conditions. Power response to throttle adjustment is slow because of the high inertia of the engine rotors. However, rapid changes of effective power are obtainable by stabilizing airspeed at a power setting higher than required by use of partially opened speed brakes, then quickly changing speed brake position as changes in effective power are required. Excess power is greatest at medium to high airspeeds. Consequently, to perform any maneuver involving altitude and airspeed changes, maintain medium to high airspeeds.

STALLS.

The stall in this airplane is a mild pitch down, with dropoff usually to the left. See figure 6-2 for stall speeds for clean, landing, and takeoff configurations. At low altitudes, power-on stall IAS is approximately 3 knots

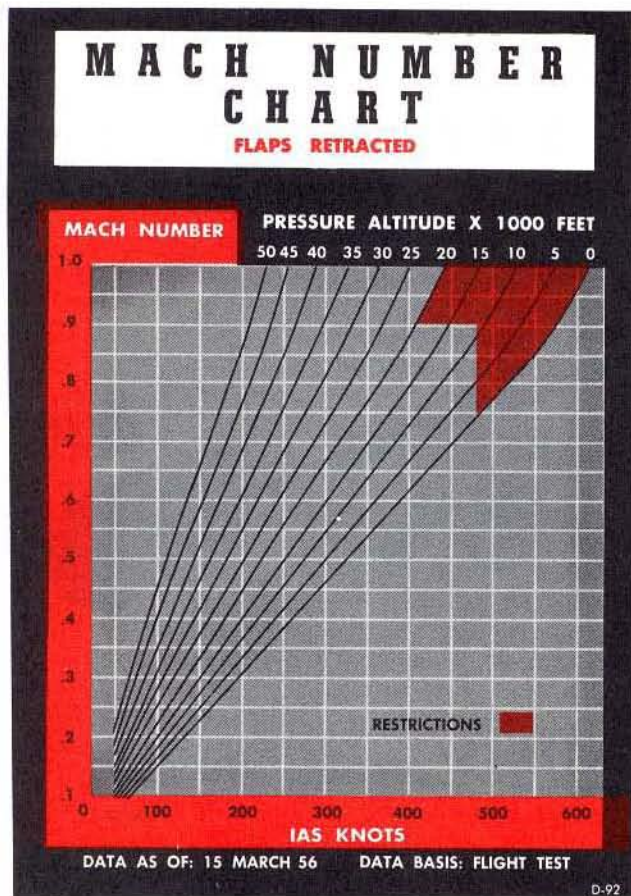


Figure 6-1.

lower than power-off stall IAS for the configurations indicated in the Stall Speed Chart. The airspeeds shown in the chart for the landing and takeoff configurations are for idle power. Ailerons and rudder retain sufficient effectiveness to maintain adequate control during a stall. Recovery from a stall is made by lowering the nose slightly and adding power as may be required. The altitude lost in a stall will be approximately 500 feet. Landing gear position does not affect stall speed. Speed brake position affects stall speed as follows: with wing flaps up, stall IAS decreases as speed brake opening increases, reaching a maximum decrease of 6 knots with speed brakes fully open. With wing flaps in the landing position, no change in stall IAS occurs until speed brakes are 30 degrees open, then stall IAS increases as speed brake opening increases, reaching a maximum increase of 7 knots with speed brakes fully open.

ACCELERATED STALLS.

At airspeeds above Mach 0.25 the accelerated stall region (shown by the sloping lines on the left of the Operating Flight Strength Diagram, figure 5-3) is characterized by buffeting, pitching, and rolling, which increase as load factor increases. Any increase of load

factor after buffet onset is accompanied by rapid loss of airspeed and extreme buffet. For this reason, the buffet region should not be penetrated beyond a mild buffet. It is recommended that accelerated stalls be practiced so that they may be anticipated by feel of the airplane.

SPINS.

Intentional spins are prohibited. Damage to the airplane's heavy complement of electronic equipment may occur from the unusual loads developed in spins. Flight tests have proved that the airplane will not spin inadvertently and has no dangerous inherent spin characteristics. However, because of the airplane's high wing loading, considerable altitude will be lost during a spin. Total altitude lost during spins varies from about 3000 feet between stall and complete recovery for a one-turn power-off spin in landing configuration, to about 12,000 feet for a three-turn spin with continuous power in clean configuration. A three-turn power-off spin in clean configuration generally requires about 10,000 feet total altitude. With the use of conventional spin recovery technique, recovery characteristics are normal. Recovery from a power-off three-turn spin in clean configuration requires between one-half and three-quarters turn, and recovery from a power-off one-turn spin in landing configuration requires from one-quarter to one-half turn. With power on, the rate of recovery is slightly slower. Spin recovery using the technique of full opposite rudder followed by forward stick, to stabilize pitch attitude as airspeed increases, is normal; however, a faster recovery can be effected by neutralizing the stick at the same time opposite rudder is applied. This technique lessens the chance of inadvertently going into a secondary inverted spin while recovering from a normal spin. Aileron position during the spin, whether with the spin, neutral, or against the spin, has no effect on the recovery. Direction of spin has no pronounced influence on spin recovery characteristics. Raising flaps and closing speed brakes aid spin recovery.

FLIGHT CONTROLS.

The full-powered irreversible flight control system gives the airplane good handling characteristics. Artificial stick feel provides a definite sense of control and is adequate under normal conditions. Control forces remain within moderate limits through a wide range of airspeeds.

ELEVATOR.

Elevator control is satisfactory under normal operating conditions. However, between Mach 0.72 and 0.78 the elevator becomes extremely effective, and very small deflections are required to obtain an additional "G" of acceleration. Since the maximum power climb

STALL SPEED CHART

WITH OR WITHOUT PYLON TANKS

GEAR UP OR DOWN

STALLING SPEED IAS KNOTS

WING FLAP POSITION	SPEED BRAKE POSITION	ANGLE OF BANK	PRESSURE ALTITUDE FEET	GROSS WEIGHT POUNDS				
				18,000	20,000	24,000	42,000	48,750

0°	CLOSED	0°	0	106	116	123	130	138
			5,000	106	117	124	131	139
			10,000	106	117	125	132	142
			20,000	108	122	131	140	150
			30,000	116	133	144	155	167
			40,000	131	151	163	174	182
			45,000	138	155	166	176	182
		30°	0 TO 5,000	114	126	133	139	145
		45°		127	140	149	158	170
		60°		153	172	185	198	211

POWER
ON

30°	CLOSED	0°	0 TO 5,000	99	109	116	122	129
		30°		106	117	124	131	138
		45°		116	128	136	144	153
		60°		138	156	168	180	193
50°	½ OPEN	0°		98	108	114	120	127
		30°		104	115	122	128	135
		45°		114	126	134	142	152
		60°		135	154	166	178	191

IDLE
POWER

DATA AS OF 15 MARCH 86

DATA BASIS: FLIGHT TEST

D-72

Figure 6-2.

schedules are at these Mach numbers, more than normal effort may be necessary in turbulent air to hold to a close climb schedule. A slight nose heaviness occurs at about Mach 0.82. This nose-down tendency can be trimmed out; however, if during a turn or other maneuver, the airspeed drops from 3 to 5 knots, the airplane will pitch up rather sharply. At high indicated airspeeds or at high Mach numbers, elevator control will be limited as shown on the Operating Flight Strength Diagram (figure 5-3). Under these conditions, twisting and bending of the airplane structure, together with high Mach effects, cause elevator effectiveness to decrease rapidly, approaching zero at sea level at approximately Mach 0.925 (which is above the maximum airspeed restriction of the airplane). This is due to high dynamic pressures associated with high airspeeds at low altitude, and high Mach number effects at high altitude. The result is that the maximum load factor attainable at high airspeeds at a given altitude will decrease as airspeed increases above about Mach 0.82. This means that the higher the airspeed the fewer the available "G's." At speeds of Mach 0.90 and above, elevator effectiveness is so reduced that less than 2 "G's" are available at Mach 0.98 at 35,000 feet (an important point to remember during a high Mach dive recovery).

CAUTION

If airplane control should become sluggish at altitudes above 30,000 feet, check the hydraulic reservoir pressure. If pressure is below operating limits, reduce altitude until control response is again normal.

"G" Overshoot.

As positive or negative load factor develops on the airplane, an elevator force-feel bobweight tends to move the stick in the opposite direction opposing further stick application. For each "G" increase, the bobweight

increases force against the stick 4.5 pounds. It must be remembered, however, that if the stick is moved abruptly, it is possible to obtain elevator position corresponding to high "G's" before the "G's" have built up on the airplane and have increased the stick force through the action of the bobweight. This is apparent particularly between Mach 0.65 and Mach 0.80. Once the "G" load starts to develop, the buildup to the point of failure can occur before corrective action becomes effective. Thus, by abruptly pulling back on the stick indiscriminately, it is possible to overshoot the "G" limit and pull the airplane apart. *When you're at low altitudes, do not attempt abrupt pull-ups.* Do not rely upon the feel of the stick to keep you out of trouble.

AILERONS.

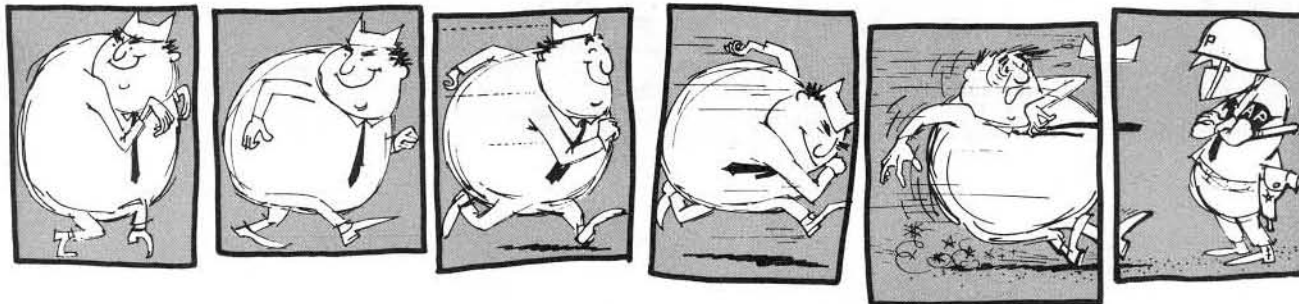
Aileron effectiveness is adequate under all conditions other than in spins and at extreme airspeeds (above Mach 0.85), where aileron effectiveness decreases rapidly. However, sufficient lateral control for performing normal maneuvers at these extreme airspeeds can be maintained with speed brakes opened approximately 5 degrees. Partially opening the speed brakes (from 10 to 20 degrees) also improves aileron effectiveness at medium airspeeds (above Mach 0.75).

RUDDER.

Rudder operation is satisfactory under all operating conditions. The sideslip stability augments should be turned on before takeoff and left on for the duration of the flight. This system operates automatically to damp out any sideslipping or rolling tendencies induced by high speed and high altitude effects; through a signal derived from movement of the aileron controls, the system also applies rudder in a turn in proportion to aileron deflection, thereby enabling the pilot to make coordinated turns with ailerons alone.

SPEED BRAKES.

The split-aileron speed brakes provide a much larger drag surface than other types, making them highly



**DECELERATING...
WITH SPEED BRAKES**

**TOP LEVEL FLIGHT SPEED TO STALL SPEED
IN LESS THAN 1 MINUTE**

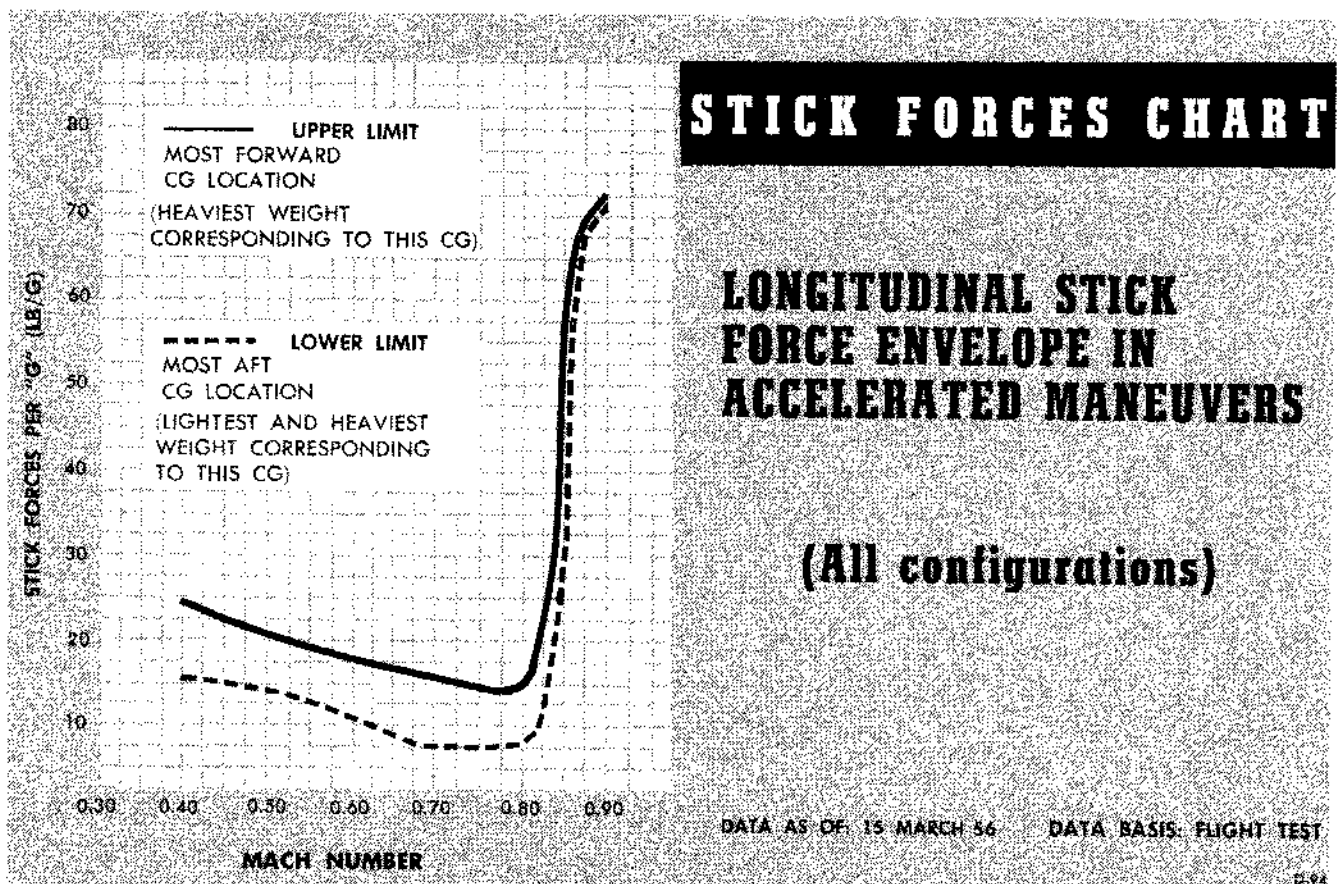


Figure 6-3.

effective under all operating conditions. Lateral control is improved at Mach numbers near cruise and above by slightly opened speed brakes. Since the speed brakes are symmetrical and are located almost in line with the airplane center of gravity, their use has little effect on trim. There is ample and positive control about all axes with speed brakes in any position. Pitch and yaw characteristics are not directly affected by their use. Letdowns up to 30,000 feet per minute can be made without exceeding 350 knots IAS. Altitude loss is reduced by using speed brakes in high speed dive recoveries; however, as the speed increases above Mach 1.90, speed brake effectiveness decreases. Above approximately 260 knots the speed brakes will not open fully. At Mach 0.90 they will only open approximately 30 degrees; and because of adverse compressibility effects, little drag may result from their use. Speed brakes are especially effective in controlling airspeed and altitude during approach. During landing, this airspeed control permits fast acceleration for go-arounds. Ground roll is reduced appreciably by moving the speed brakes to full open after touchdown. They give excellent airspeed control at constant throttle

settings, thus permitting a high rate of closure in combat while retaining maximum power for a fast breakaway. At high indicated airspeeds, sufficient lateral control for maneuvering can be maintained with speed brakes 5 to 10 degrees open without affecting airspeed. A 5-degree speed brake opening will also eliminate the natural rolloff tendency at high Mach numbers.

Note

By moving speed brake lever to the full open position and reducing power, the airplane can be decelerated in level flight from maximum speed to stalling speed in less than 1 minute at any altitude.

TRIM.

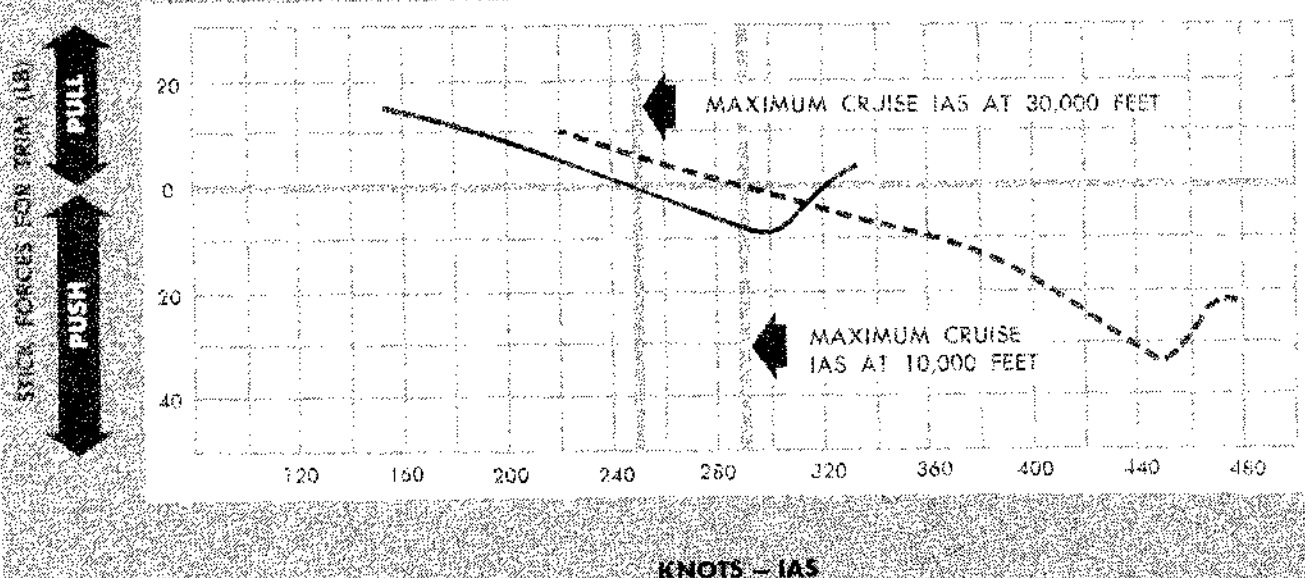
Longitudinal trim is not affected by lowering the landing gear during approach or by changes in thrust at high airspeeds. However, when shutting down afterburners between approximately Mach 0.84 and Mach 0.88, the high speed can no longer be maintained

STICK FORCES CHART

LONGITUDINAL STICK FORCES WHEN CRUISING

(All configurations)

WT 35,000 LB CG 24% MAC



DATA AS OF 15 MARCH 56

DATA BASIS: FLIGHT TEST

Figure 6-4.

(in level flight) and a push force on the stick is required as airspeed decreases, requiring retrimming at the lower airspeed. Nominal change in longitudinal trim is required when changes in thrust are made at low airspeeds. When speed brakes are opened, no immediate change in trim is required; however, as airspeed is reduced, longitudinal trim may be necessary. The aileron trim motor is independent of stick position. When trimming the elevator, the trim mechanism will not operate after the stick force is reduced to zero for any given stick position. Elevator trim will appear more sensitive at cruise speeds as less elevator is required to trim for a small change in speed in this region. Normal available rudder trim is 5 degrees left or right. Under normal flight conditions, the emergency rudder trim knob should not be used, as the sideslip stability augments system will be adversely affected.

HIGH AIRSPEED OVERTRIM.

Stick forces vary with airspeed changes (see figure 6-3) and can be trimmed out for level flight. However, for

flight at relatively low altitudes, extreme caution should be used in trimming out all the stick force. If all the push force required for level flight at relatively high airspeeds is trimmed out, and the airplane then slows down, it is possible for the pull force required for level flight (at the lower airspeed) to build up in magnitude faster than the pilot anticipates, causing the airplane to nose down sharply (an unsafe attitude with the airplane close to the ground).

WARNING

Do not trim out all stick push force during low-level flight at high airspeeds as the airplane may dive sharply as airspeed is reduced.

LEVEL FLIGHT CHARACTERISTICS.

At any operating altitude and at all airspeeds, except the range between Mach 0.80 and Mach 0.86, a push force on the stick is required as airspeed is increased

if 1 "G" flight is to be maintained. As airspeed is increased from Mach 0.80 to Mach 0.86 a slight relaxation in push force is required to maintain 1 "G" flight.

LOW SPEED.

The handling characteristics of the airplane at low airspeeds are good, except that near 1 "G" stall, rolling response to aileron motion may be slightly lower than normal.

CRUISING AND HIGH SPEED.

With the exception of the elevator stick force and position characteristics previously explained, no unusual characteristics will be experienced in the medium to high airspeed range. Figure 6-4 shows a typical variation of stick force with the airplane trimmed to fly "hands off" at cruise airspeed, and indicates the airspeed range of the mild reversal in normal stick force variation.

Buffet—1 "G" Flight.



During 1 "G" flight you will experience a mild compressibility buffet in the airspeed range from Mach 0.85 to Mach 0.90. This buffeting effect, which can be likened to driving a car along a washboard road, is not considered objectionable. The intensity of buffeting increases slightly with airspeed while in the buffet range, but practically disappears above Mach 0.90.

High-Airspeed Wing Drop.

At airspeeds between Mach 0.85 and Mach 0.90 (the same range in which light buffeting is experienced in level flight) the wing-drop, common to many jet airplanes at high Mach numbers, is most likely to occur. Wing-drop may be either to the right or left, but is

usually to the left and can be eliminated by opening the speed brakes approximately 5 degrees.

MANEUVERING FLIGHT.

STICK FORCES.

In level flight, minimum stick forces per "G" will occur at airspeeds in the region of Mach 0.78 (see Stick Force Chart, figure 6-4). Because of light stick forces, care must be exercised when maneuvering near this airspeed not to exceed the allowable load factor by overcontrol. If the airplane enters accelerated flight above Mach 0.80, the stick force necessary to pull load factor will be high, but may be partially trimmed out to a comfortable value. However, never trim out all of the stick force while in accelerated maneuvers. If enough stick force is applied and held to pull the desired load factor, either by trim or pilot effort, the applied stick force will result in a rapid increase in load factor as airspeed drops. This can result in rapidly exceeding the design or even the ultimate load factor.



Use no more elevator trim than necessary during maneuvers. Use extreme caution to avoid excessive "G's" as airspeed decreases during high-speed maneuvers.

LOAD FACTORS.

The maximum permissible symmetrical flight load factor of 5.67 (as specified for an all-weather interceptor) is the highest allowable under any flight conditions. Above approximately 20,000 feet it is impossible to attain 5.67 load factor because the airplane will either be forced into

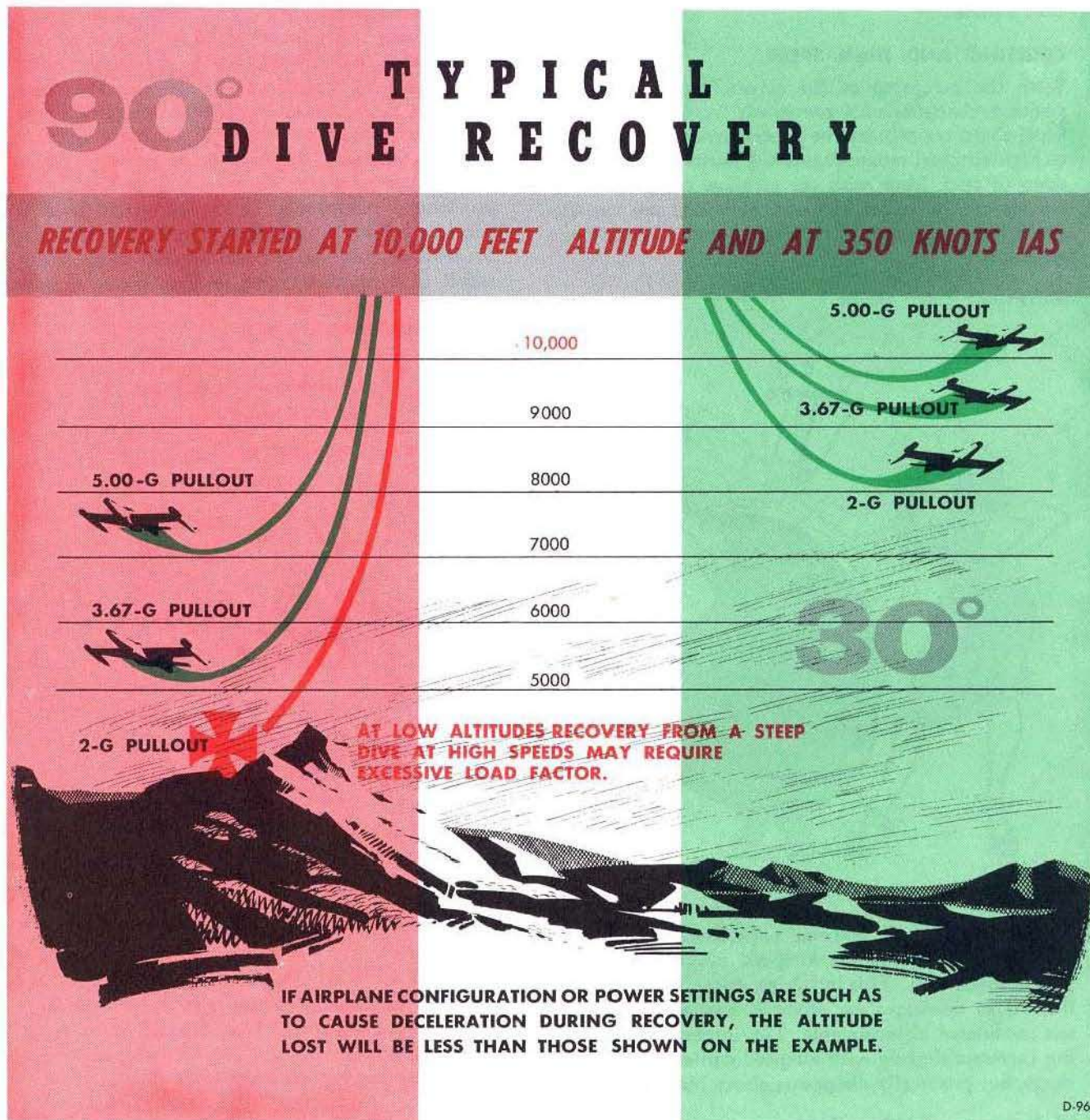


Figure 6-5.

an accelerated stall or the elevator control power limit will be reached. At these altitudes, the airplane is controllable at high Mach numbers and its flight characteristics are normal for a high performance airplane. At medium to high airspeeds at low altitudes, this airplane, like all high performance airplanes, can be overstressed to the point of structural failure; therefore, the airplane is limited to a load factor of 5.00 below 12,000 feet. Flying at high indicated airspeeds at low altitudes is dangerous because elevator effectiveness, or ability to develop load factor, can change within wide limits with relatively small changes in airspeed. Do not attempt abrupt pull-ups at low altitudes, and do not rely entirely on stick feel to keep you out of trouble. Be aware of the definite distinction between the structural strength of an interceptor and of a fighter designed for fighter-versus-fighter combat.

DIVING.

At any gross weight, the altitude lost during recovery is dependent on the altitude at which recovery is started, the angle from which the recovery is made, airspeed at start of recovery, and the load factor ("G's") held during recovery. See figure 6-5 for examples of typical dive recovery flight paths.

Note

- Altitude lost during dive recovery as shown in the Typical Dive Recovery illustration (figure 6-5), and Dive Recovery Charts (figure 6-6), does *not* include the altitude lost entering the dive.
- Dive recovery charts are based on a constant airspeed being held during entire recovery.

The Dive Recovery Charts (figure 6-6) show the interrelation between these variables. The charts should be studied collectively in order to understand the capabilities of the airplane and to be able to exercise proper judgment in planning dive maneuvers. The limiting airspeed lines on these charts represent the maximum and minimum operating airspeeds at which the airplane may be flown at a specific pressure altitude, and for which the load factor designated on the chart is attainable. At minimum airspeeds (maximum lift lines) an accelerated stall will occur. At airspeeds greater than the maximum (elevator power limit lines), elevator control is limited by aeroelastic distortion of the airplane structure and by elevator control power to such an extent that the airplane can no longer develop the load factor shown on the chart. The resultant effect causes the maximum attainable load factor to decrease rapidly (and therefore increases the altitude lost during recovery) for a relatively small increase in IAS

above the limiting value shown on the chart. See figure 6-6 (Sheet 1 of 5) for instructions on chart use.

WARNING



The altitude and IAS at which a maximum (allowable or attainable) load factor recovery is started should be anticipated so as not to exceed airspeed restrictions (470 knots IAS or Mach 0.90, whichever is the lower) and to ensure at least the minimum ground clearance.

HIGH MACH DIVE.

Performing a high Mach dive at high altitude is the best way to become familiar with the high Mach characteristics of the airplane. This maneuver is useful in combat for a breakaway, as an evasive maneuver, or as an effective way to let down rapidly. Since the purpose of the high Mach dive is to lose altitude as rapidly

how to read dive recovery charts...

THE DOTTED LINES (STALL LIMITS) ON THE LEFT OF THE CHART SHOW THE AIRSPEED AT WHICH THE AIRPLANE WILL ENTER AN ACCELERATED STALL WHILE PULLING THE "G's" SHOWN ON THE CHART.

----- STALL LIMITS FOR 30,700 LB GROSS WEIGHT

----- STALL LIMITS FOR 46,600 LB GROSS WEIGHT

THE SOLID LINES (ELEVATOR CONTROL POWER LIMITS) ON THE RIGHT OF THE CHART SHOW THE MAXIMUM AIRSPEEDS AT WHICH THE "G's" SHOWN ON THE CHART CAN BE PULLED. GREATER SPEEDS WILL RESULT IN DECREASED ELEVATOR EFFECTIVENESS.

— ELEVATOR CONTROL POWER LIMITS FOR 30,700 LB GROSS WEIGHT

— ELEVATOR CONTROL POWER LIMITS FOR 46,600 LB GROSS WEIGHT

EXAMPLE

1

ALTITUDE at start of PULLOUT (25,000 FEET).

2

MOVE TO RIGHT, to AIRSPEED at start of PULLOUT (300 KNOTS).

3

MOVE DOWN CHART to DIVE ANGLE CURVE (60°).

4

MOVE TO LEFT and READ from this SCALE, the ALTITUDE LOST during DIVE RECOVERY (6300 FEET).

IF AIRPLANE CONFIGURATION OR POWER SETTINGS ARE SUCH AS TO CAUSE DECELERATION DURING RECOVERY, THE ALTITUDE LOST WILL BE LESS THAN THOSE SHOWN ON THE EXAMPLE.

ALTITUDE AT START OF PULLOUT

1

2

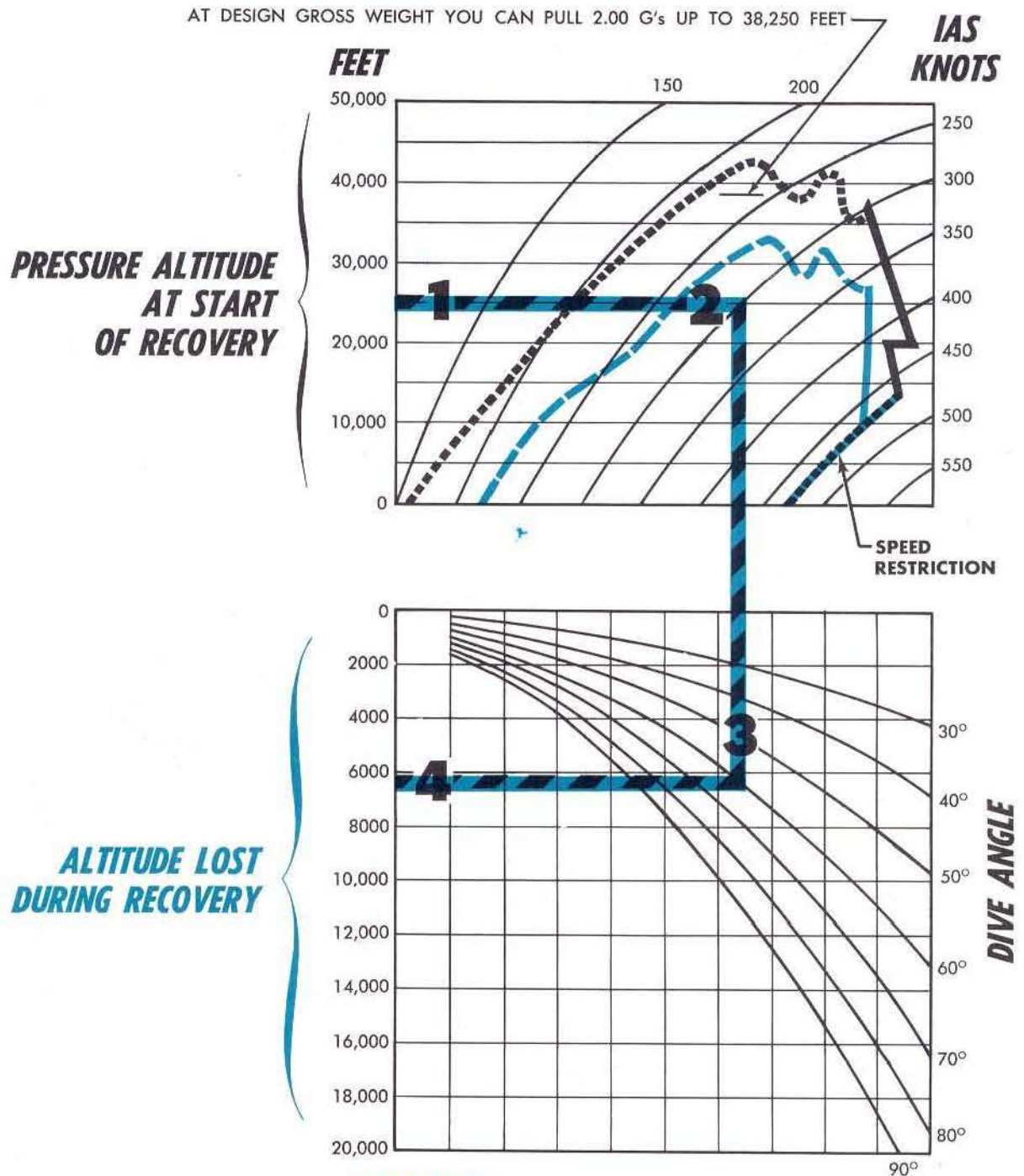
AIRSPEED AT START OF PULLOUT

3

DIVE ANGLE

ALTITUDE LOST DURING DIVE RECOVERY

4



At constant

2.00-G

acceleration

DATA AS OF: 15 MARCH 56
DATA BASIS: FLIGHT TEST

ALTITUDE LOST DURING DIVE RECOVERY

D-97 (2)

Figure 6-6 (Sheet 2 of 5 Sheets).

THE DOTTED LINES (STALL LIMITS) ON THE LEFT OF THE CHART SHOW THE AIRSPEED AT WHICH THE AIRPLANE WILL ENTER AN ACCELERATED STALL WHILE PULLING THE "G's" SHOWN ON THE CHART.

----- STALL LIMITS FOR 30,700 LB GROSS WEIGHT

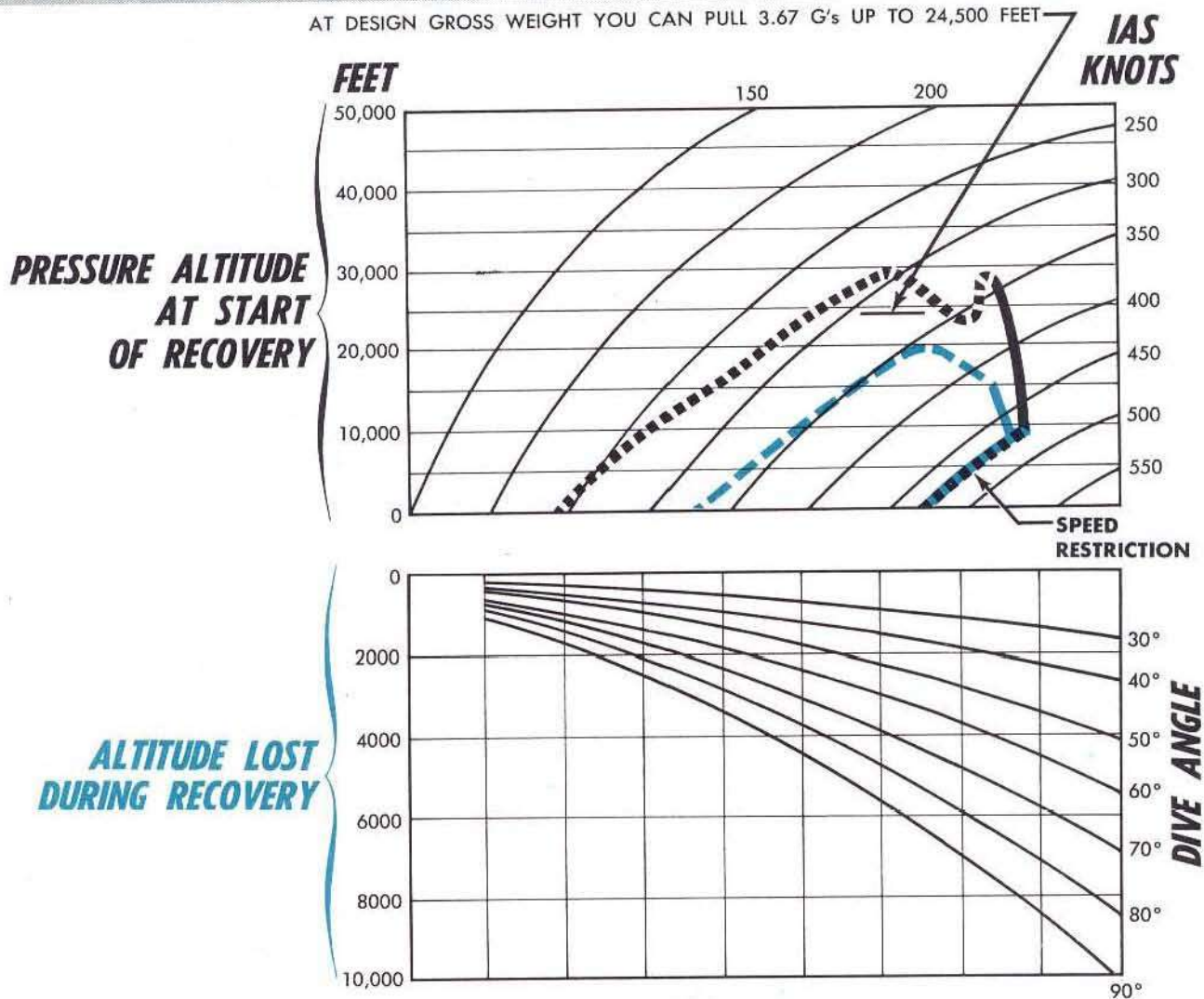
----- STALL LIMITS FOR 46,600 LB GROSS WEIGHT

THE SOLID LINES (ELEVATOR CONTROL POWER LIMITS) ON THE RIGHT OF THE CHART SHOW THE MAXIMUM AIRSPEEDS AT WHICH THE "G's" SHOWN ON THE CHART CAN BE PULLED. GREATER SPEEDS WILL RESULT IN DECREASED ELEVATOR EFFECTIVENESS.

----- ELEVATOR CONTROL POWER LIMITS FOR 30,700 LB GROSS WEIGHT

----- ELEVATOR CONTROL POWER LIMITS FOR 46,600 LB GROSS WEIGHT

AT DESIGN GROSS WEIGHT YOU CAN PULL 3.67 G's UP TO 24,500 FEET



At constant **3.67-G** acceleration

DATA AS OF: 15 MARCH 56
DATA BASIS: FLIGHT TEST

ALTITUDE LOST DURING DIVE RECOVERY

D-97(3)

Figure 6-6 (Sheet 3 of 5 Sheets).

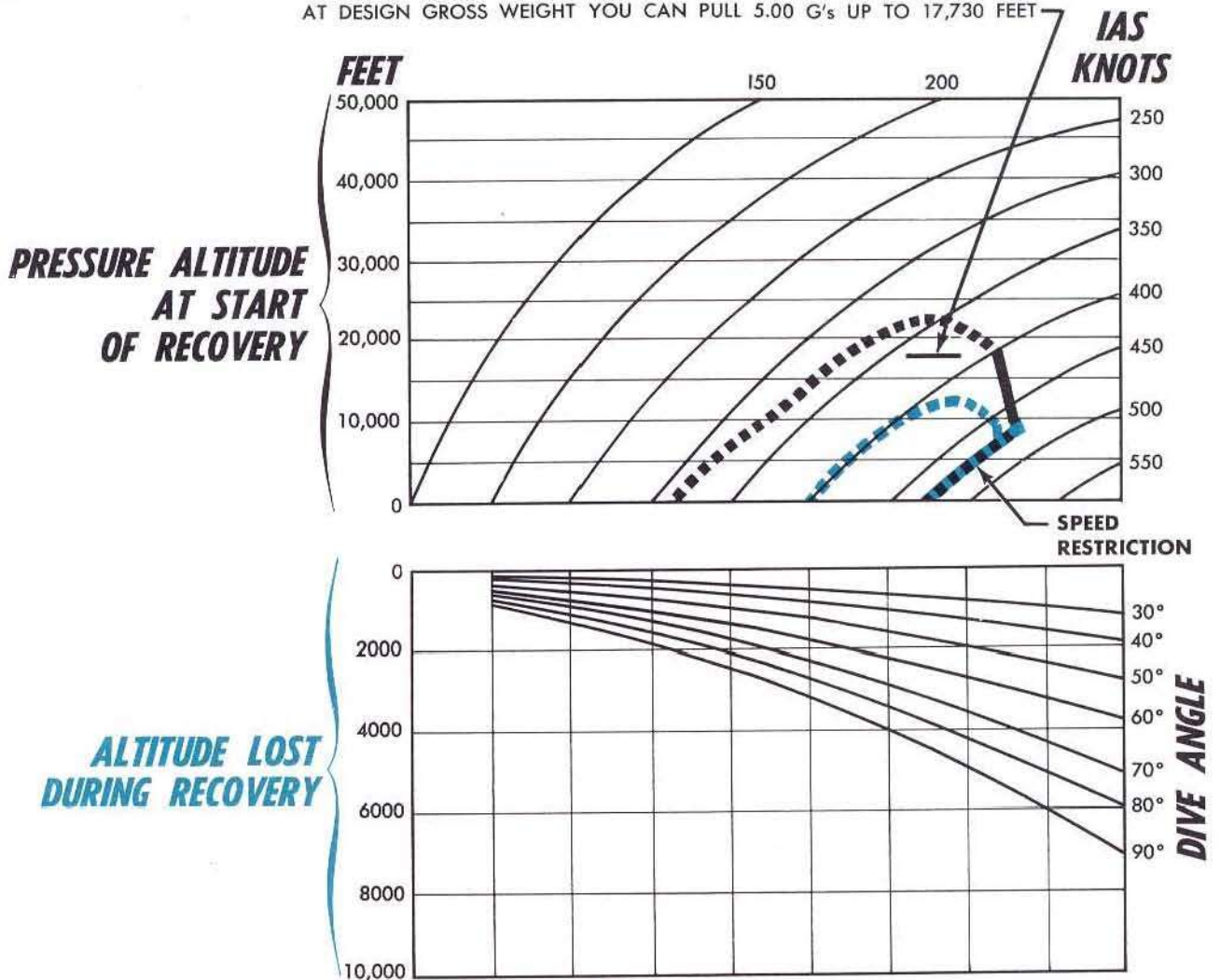
THE DOTTED LINES (STALL LIMITS) ON THE LEFT OF THE CHART SHOW THE AIRSPEED AT WHICH THE AIRPLANE WILL ENTER AN ACCELERATED STALL WHILE PULLING THE "G's" SHOWN ON THE CHART.

- STALL LIMITS FOR 30,700 LB GROSS WEIGHT
- STALL LIMITS FOR 46,600 LB GROSS WEIGHT

THE SOLID LINES (ELEVATOR CONTROL POWER LIMITS) ON THE RIGHT OF THE CHART SHOW THE MAXIMUM AIRSPEEDS AT WHICH THE "G's" SHOWN ON THE CHART CAN BE PULLED. GREATER SPEEDS WILL RESULT IN DECREASED ELEVATOR EFFECTIVENESS.

- ELEVATOR CONTROL POWER LIMITS FOR 30,700 LB GROSS WEIGHT
- ELEVATOR CONTROL POWER LIMITS FOR 46,600 LB GROSS WEIGHT

AT DESIGN GROSS WEIGHT YOU CAN PULL 5.00 G's UP TO 17,730 FEET



At constant **5.00-G** acceleration DATA AS OF: 15 MARCH 56
 DATA BASIS: FLIGHT TEST

ALTITUDE LOST DURING DIVE RECOVERY

D-97(4)

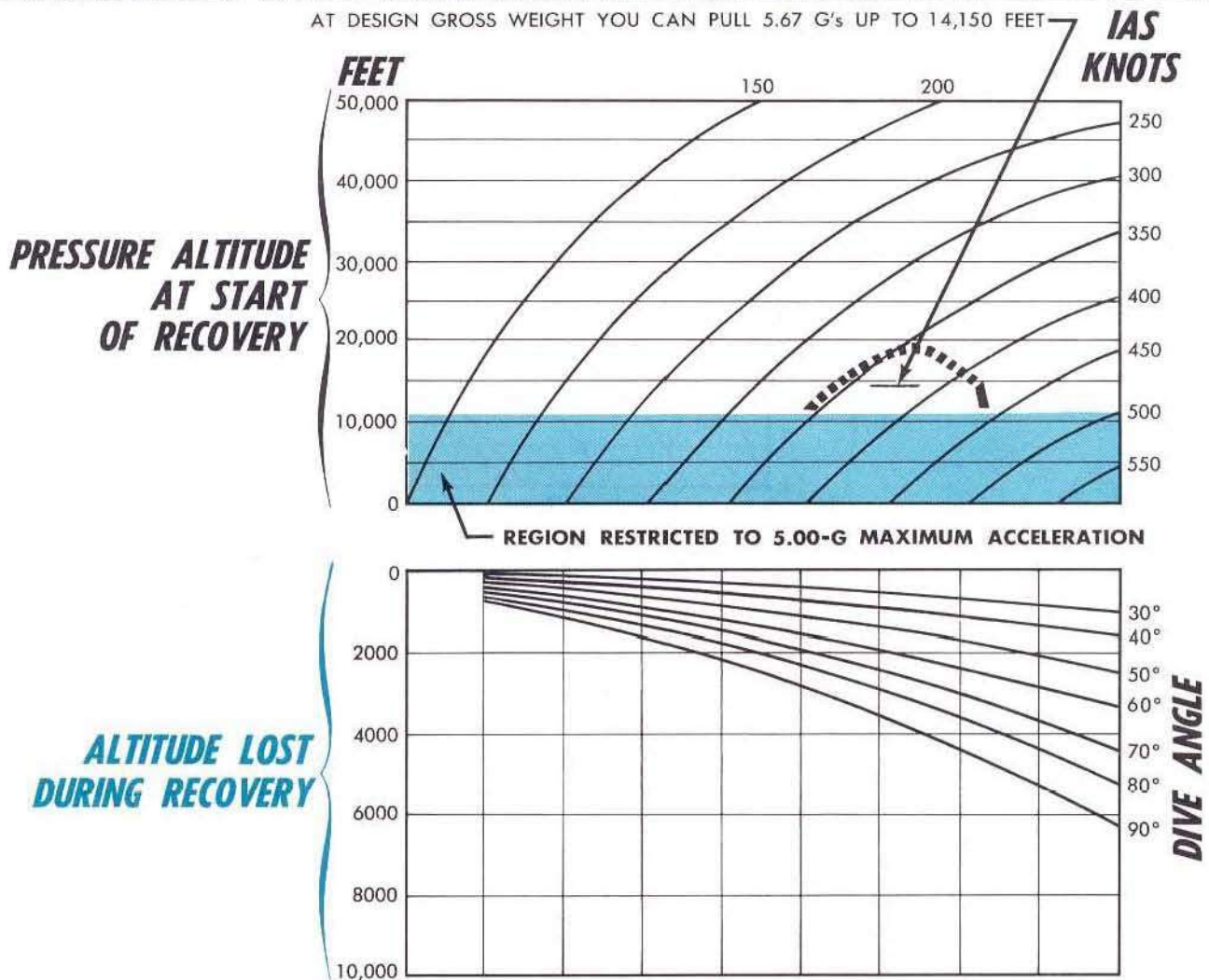
Figure 6-6 (Sheet 4 of 5 Sheets).

THE DOTTED LINES (STALL LIMITS) ON THE LEFT OF THE CHART SHOW THE AIRSPEED AT WHICH THE AIRPLANE WILL ENTER AN ACCELERATED STALL WHILE PULLING THE "G's" SHOWN ON THE CHART.

THE SOLID LINES (ELEVATOR CONTROL POWER LIMITS) ON THE RIGHT OF THE CHART SHOW THE MAXIMUM AIRSPEEDS AT WHICH THE "G's" SHOWN ON THE CHART CAN BE PULLED. GREATER SPEEDS WILL RESULT IN DECREASED ELEVATOR EFFECTIVENESS.

.....STALL LIMITS FOR 30,700 LB GROSS WEIGHT

————ELEVATOR CONTROL POWER LIMITS FOR 30,700 LB GROSS WEIGHT



At constant **5.67-G** acceleration

DATA AS OF: 15 MARCH 56
DATA BASIS: FLIGHT TEST

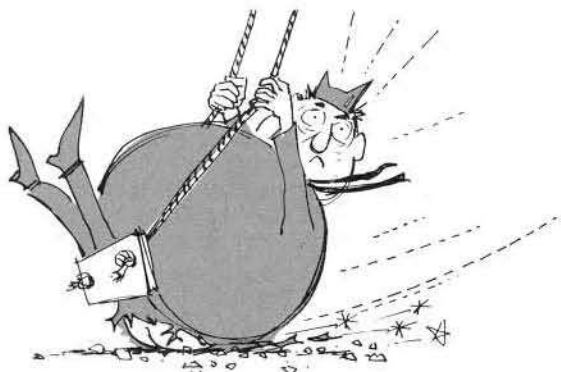
ALTITUDE LOST DURING DIVE RECOVERY

D-97(5)

Figure 6-6 (Sheet 5 of 5 Sheets).

as possible, enter the dive with maximum power and at high IAS and get into a 60-degree dive as soon as possible.

WARNING



DF-60

Generally, the steeper you dive, the greater the airspeed; however, as the angle of the dive is increased steeper than 60 degrees the increase in speed is negligible. Dive angles steeper than 60 degrees result in far greater altitude loss during recovery. At speeds associated with high Mach dives (Mach 0.90 and above) elevator and speed brake effectiveness are greatly reduced. Because of the reduced elevator effectiveness at Mach 0.98 at 35,000 feet, less than 2 "G's" are available; therefore, until the airplane is slowed down, the elevator will have little effect for recovery. At speeds of Mach 0.90 and above, the speed brakes will open only partially; and because of adverse compressibility effects, little drag will result from their use. In a vertical or nearly vertical dive at high Mach numbers, any delay in starting recovery, combined with the greatly reduced elevator and speed brake effectiveness, may result in such loss of altitude that recovery may be impossible. Therefore, use extreme caution in performing high Mach dives at angles greater than 60 degrees, and make certain that recovery from *any* high Mach dive is initiated no lower than 35,000 feet. The flight path for the 90-degree dive shown in figure 6-7 illustrates the excessive loss of altitude during vertical dive recovery.

Enter the dive with a wingover. Maintain positive "G's" throughout the dive to prevent flameout. Since in a steep dive a high percentage of the airplane's momentum is caused by weight as compared to engine thrust, the speed of descent can be varied only within relatively narrow limits by throttle changes. Observe the effect of buffet as the airplane accelerates to high

Mach numbers and again as it decelerates during pullout. The airplane has normal dive attitude and responds to a normal recovery technique. Begin normal recovery procedure at approximately 35,000 feet. See figure 6-7 for correct procedure.

WARNING

Do not use excessive elevator trim in recovering from a dive. When airplane slows down during pullout, elevators become more effective, and applied trim may result in pulling "G's" in excess of the load factor limit.

At approximately Mach 0.75, stick pressure is light and elevators are most sensitive. Exercise caution in this airspeed range so that design load factor is not exceeded. Because of elevator power limits you may be able to pull only approximately 1.3 "G's" at the beginning of recovery and about 2.5 "G's" maximum at the end of the pullout. The exact available load factor is, of course, dependent on Mach number and altitude.

WARNING



DF-55

Since the airplane can lose altitude rapidly, avoid steep low-level dives.

FLIGHT WITH ASYMMETRICAL LOADING.

Flights with asymmetrical loading should be avoided if possible. The most probable cause of asymmetrical

loading would be uneven fuel consumption between the left and right fuel systems. If, through malfunction or mismanagement of the fuel system, an asymmetrical load condition develops, first attempt to correct the condition by balancing fuel load (see Section VII) or dumping tip tank fuel. However, if this cannot be done, land as soon as practicable to preclude the possibility of the condition becoming worse. In flight tests, the airplane has been flown and landed with the asymmetrical load condition of one full and one empty tip tank. When flying in this condition, lateral control cannot be maintained down to stall speed using trim alone, but requires additional aileron stick force. With trim alone, control can be maintained with full flaps down to about 150 knots IAS. Flying near stall speed is not recommended because nearly full aileron deflection is necessary to maintain level flight. Landing may be made using about one-half aileron and an airspeed above 140 knots IAS until just before touchdown to provide adequate lateral control.

Note

With clean configuration in level flight, the airplane may start to snake through the air at about 280 knots IAS if the sideslip stability augments is not operating properly.

FLIGHT WITH EXTERNAL LOADS.

Flight characteristics (such as buffet, stall, stability, and control) are essentially the same with or without pylon tanks except for the restrictions covered in Section V. Pylon tanks should be dropped before entering combat.

Note



External stores other than pylon tanks will not be carried.

CAUTION

- 1** DOUBLE CHECK OPERATION OF ALL CONTROL SURFACES AND HYDRAULIC SYSTEMS. IT IS MANDATORY THAT BOTH LEFT AND RIGHT SYSTEMS BE OPERATING AT NORMAL PRESSURE FOR SATISFACTORY CONTROL DURING A HIGH MACH DIVE AND RECOVERY.
- 2** AFTERBURNERS — ON.
- 3** OPEN SPEED BRAKES 5 DEGREES TO PREVENT WING DROP.
- 4** ENTER 60-DEGREE DIVE IN A DIVING TURN, MAINTAINING POSITIVE "G's" TO PREVENT FLAMEOUT.
- 4** ENTER 90-DEGREE DIVE WITH A HALF ROLL. MAINTAIN MAXIMUM AVAILABLE "G's" THROUGHOUT DIVE AND RECOVERY.
- 5** ESTABLISH ANGLE OF DIVE AS SOON AS POSSIBLE.
- 6** RETARD THROTTLES TO IDLE AND PLACE SPEED BRAKE LEVER AT FULL OPEN. PULL AND MAINTAIN MAXIMUM AVAILABLE LOAD FACTOR (LIMITED EITHER BY ELEVATOR POWER OR BUFFET). YOU CAN EXPECT TO PULL APPROXIMATELY 1.4 "G's" AT THE BEGINNING OF THE PULLOUT.

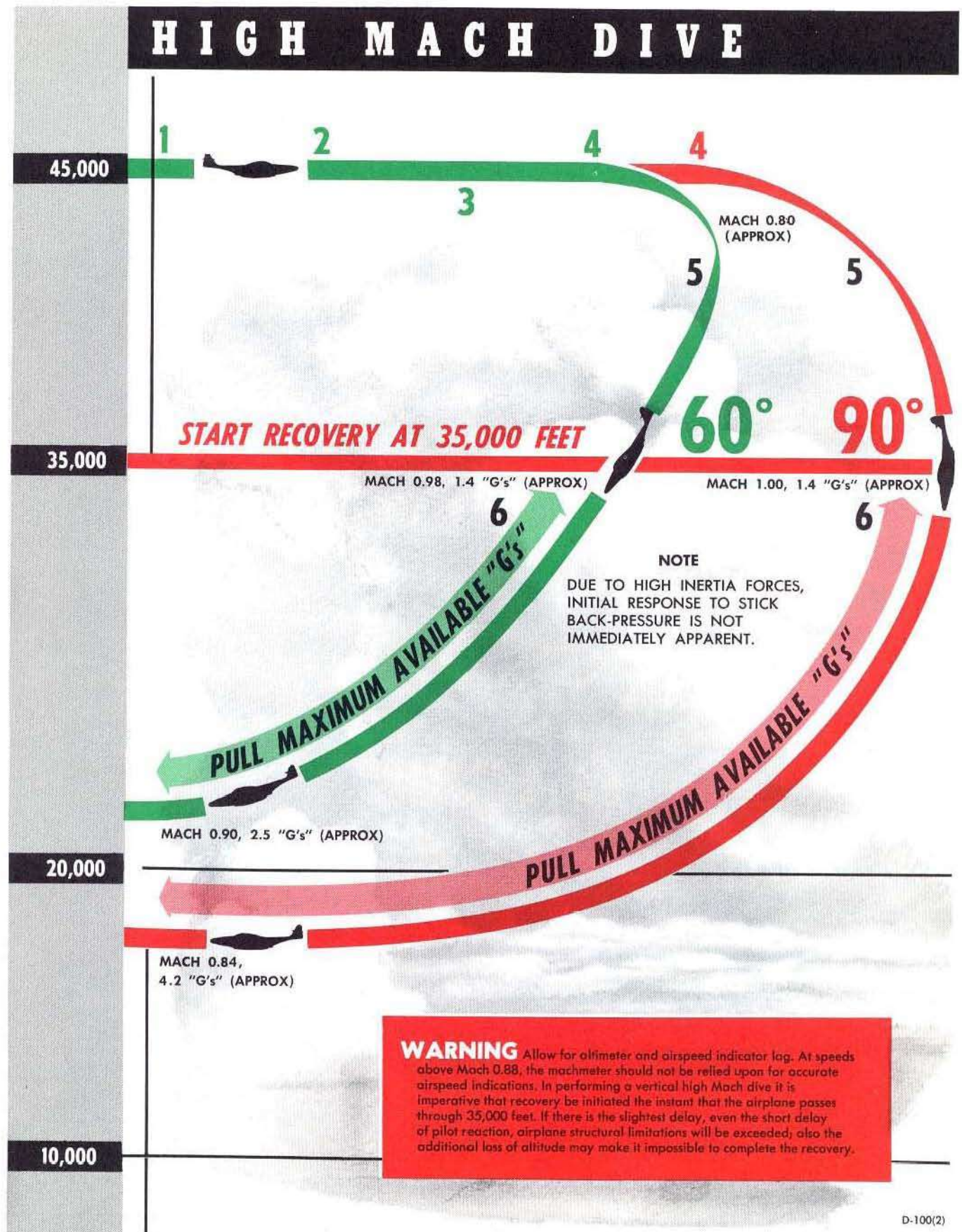


Figure 6-7.





DF-7

SYSTEMS OPERATION

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ENGINE.

BURST ACCELERATION.

If conditions warrant, the engines can be burst accelerated by moving the throttles rapidly to OPEN. The engine fuel control will meter out the fuel required by the engine, but normally will not pass sufficient fuel for excessive exhaust gas temperatures or rpm above 100%.

Note

During a burst acceleration from 80% rpm to maximum power, a compressor stall may result. This will be noted by audible pulsation, lag in rpm, and increase in tailpipe temperature above limits.

COMPRESSOR STALL.

Compressor stall may occur at times during engine acceleration, and can be recognized by a loud rumble and vibration in the engine and rapid exhaust gas temperature rise, accompanied by rpm stagnation or drop. Compressor stall is caused by a back pressure

at the compressor outlet, which in turn is usually caused by an exceedingly rich fuel mixture. Under stall conditions, considerably greater than normal resistance to compressor rotation is encountered, resulting in the rumble, or surge, previously described. Compressor stall is most likely to be encountered under high ambient temperature conditions during accelerations from below 80% rpm to higher rpm, as compressor stall on the J35-35 engine is a phenomenon of acceleration only and will not occur at stabilized power settings. Since compressor stall is most likely to occur at approximately 80% rpm, it is recommended that engine rpm be maintained at 85% rpm or above on final approach until committed to landing. In addition, it is suggested that acceleration through the 80% rpm range be made with rapid advancement of the throttle to full open position, in order to obtain open eyelid conditions. If compressor stall is experienced, the throttle should be retarded to below the 80% rpm position and exhaust gas temperature should be allowed to drop to normal before advancing the throttle. If engine temperature exceeds the permissible limitation, notation of this fact should be made in DD Form 781 after landing so that an engine overheat inspection will be made.

EXHAUST GAS TEMPERATURE VARIATION.

Exhaust gas temperature is affected by outside air temperature, altitude, and airspeed. With constant rpm, exhaust gas temperature generally decreases with an increase in altitude and increases with greater airspeed and higher ambient temperatures. These factors can change singly or in combination to cause variable exhaust gas temperatures at any given rpm. If the engines are operating at military power, the exhaust gas temperatures may decrease approximately 65 degrees as the altitude increases. Using maximum power the exhaust gas temperatures drop a maximum of approximately 60 degrees between takeoff and absolute ceiling. There is no direct control for regulating the exhaust gas temperature; however, temperature can be indirectly controlled by throttle settings. Starting the afterburner causes a slight increase in exhaust gas temperature and a drop in engine rpm. This condition is temporary and both temperature and rpm soon stabilize.

ENGINE OVERSPEEDING AT ALTITUDE.

The engine will operate at sea level, with or without afterburning, within the limits preset on the engine fuel control. However, when operating at altitude, the fuel requirements without afterburning are somewhat reduced and there is a possibility that the engine may overspeed. Under most conditions the governor will prevent the engine from exceeding 100% rpm, but because of the inherent acceleration lag of the engine fuel control governors, a slight engine overspeeding in excess of 100% rpm may occur. In the event of overspeeding, retard the throttle to a setting that will prevent exceeding a stabilized rpm of 100%.

INLET DUCT NOISE.

Because of the mass flow properties of the air entering the engine air intake ducts, it is possible to obtain combinations of engine and airplane speeds which will result in fluctuation of airflow through the engine transition ducts (duct rumble). This condition will exist, on Groups 1 and 5 airplanes, at altitudes below 20,000 feet and must be avoided. With the engines operating, duct rumble can be eliminated either by advancing the throttles or reducing airspeed with speed brakes. Duct rumble on a windmilling engine can be eliminated by reducing airspeed but maintaining a safe margin above stall. On Group 10 and subsequent airplanes, the installation of vortex generators (figure 1-3) has suppressed the fluctuation of airflow through the engine transition duct to such an extent that duct rumble should not occur during descent at routine airspeeds.

EYELID OPERATION (GROUPS 1 THROUGH 20 AIRPLANES).

The eyelids are provided to increase the diameter of the tailpipe nozzle during afterburning. This is to permit

an increase in thrust without operating at prohibitively high temperatures. During nonafterburning operation the eyelids are closed. The eyelids are operated by two pneumatic cylinders that derive their power from the 11th stage of the engine compressor. The compressor air is directed to either side of the pneumatic cylinders by a solenoid valve which is controlled through a pressure differential switch by differential exhaust pressures within the tail cone. If the eyelids fail to open when afterburning is selected, the exhaust gas temperature will rise and rpm will drop. If this occurs, afterburning must be shut down immediately to prevent excessive exhaust gas temperatures. If the eyelids should fail to close following afterburner operation, this will be indicated by a very low exhaust gas temperature and extreme loss of thrust.

EYELID OPERATION (GROUP 25 AND SUBSEQUENT AIRPLANES).

The eyelids are provided to increase the diameter of the tailpipe nozzle during afterburning. This is to permit an increase in thrust without operating at prohibitively high temperatures. In addition to opening in conjunction with afterburning, the eyelids will stay open during starting to prevent high temperatures, and during rapid acceleration to decrease acceleration time. An open-throttle switch and an idle switch, both operating on 28-volt dc, are in the No. 4 inlet duct island and are mechanically actuated by the throttle shaft. The idle switch will be actuated when the throttle is at IDLE or below and will cause the eyelids to stay open in this speed range. The open-throttle switch is actuated when the throttle is full open and causes the eyelids to open during burst accelerations, or when the throttle is opened faster than engine rpm rises; however, an engine speed-sensing switch will open when the engine rpm reaches 87.5%, interrupting the open-throttle switch circuit and causing the eyelids to close. If afterburning is selected during burst acceleration (by lifting the fingerlifts), the eyelids will stay open during the engine speed range from idle to 100% rpm (or from that rpm at which the burst acceleration is started). A pressure switch is in series with the idle switch and will open the idle switch circuit at 10,000-foot altitude and cause the eyelids to stay closed during high-altitude idle. When the throttles are opened slowly, the eyelids will remain closed from idle to 100% rpm since the speed switch will be actuated in advance of the open-throttle switch to maintain closed eyelids during slow acceleration. Failure of the engine speed-sensing switch, or loss of power from the primary a-c single-phase bus, will cause the eyelids to open during nonafterburning operation if the open-throttle switch is closed (throttle at 100% rpm position) and the airplane is below 10,000-foot pressure altitude (altitude switch closed). This will result in an extreme loss of thrust and low exhaust

gas temperature. However, the eyelids can be closed by moving the toggle-type afterburner control circuit breaker to the unmarked OFF position or, if trouble is caused by failure of a single-phase inverter, by moving the single-phase inverter switch to the EMER position. The eyelids are operated by two pneumatic cylinders powered by air from the 11th-stage engine compressor. The compressor air is directed to either side of the pneumatic cylinders by a solenoid valve which is controlled by a pressure differential switch which senses pressure changes in the engine tail cone. If the eyelids fail to open when afterburning is selected, engine rpm will drop and exhaust gas temperature will rise. If this occurs, afterburning must be discontinued immediately to prevent excessive exhaust gas temperatures. A failure of both single-phase inverters during afterburning will have no effect on engine and afterburner performance until the afterburners are shut down. If the airplane is below 10,000 feet and the throttles at 100% rpm, the eyelids will have to be closed by moving the afterburner control circuit breaker to the unmarked OFF position. Afterburning will not be available again until the single-phase power failure is corrected. Failure of the eyelids to close following afterburner operation will result in very low exhaust gas temperature and extreme loss of thrust.

AFTERBURNER OPERATION.

STARTING AFTERBURNERS AT HIGH ALTITUDE.

If difficulty is encountered when initiating afterburning at altitudes above 45,000 feet using the normal procedure, use the following procedure:

1. Throttle—Retard to 95% rpm.
2. Throttle fingerlift—Lift, and simultaneously jab the throttle forward. Large jabs of more than 3% rpm are not recommended as they may result in over-temperature conditions. This procedure will materially decrease the time required to reach full afterburner operation.

FUEL SYSTEM OPERATION (GROUPS 1 THROUGH 70 AIRPLANES).

FUEL SYSTEM NORMAL OPERATION.

In normal fuel system operation, with the fuel selector switches at ALL TANKS and all individual tank switches at ON, fuel tank sequencing is automatic. (If pylon tanks are not carried, the pylon tank switches should be OFF.) Fuel flows to each engine from its corresponding sump tank. Each sump tank is continuously replenished: first, by the pylon tank; second, by the tip tank; and then, simultaneously, by both wing tanks. When fuel transfer from the wing tanks stops, the sump tank alone feeds the engine until one-third of the sump tank fuel is used. At this point, the nose tank cuts in and delivers fuel directly

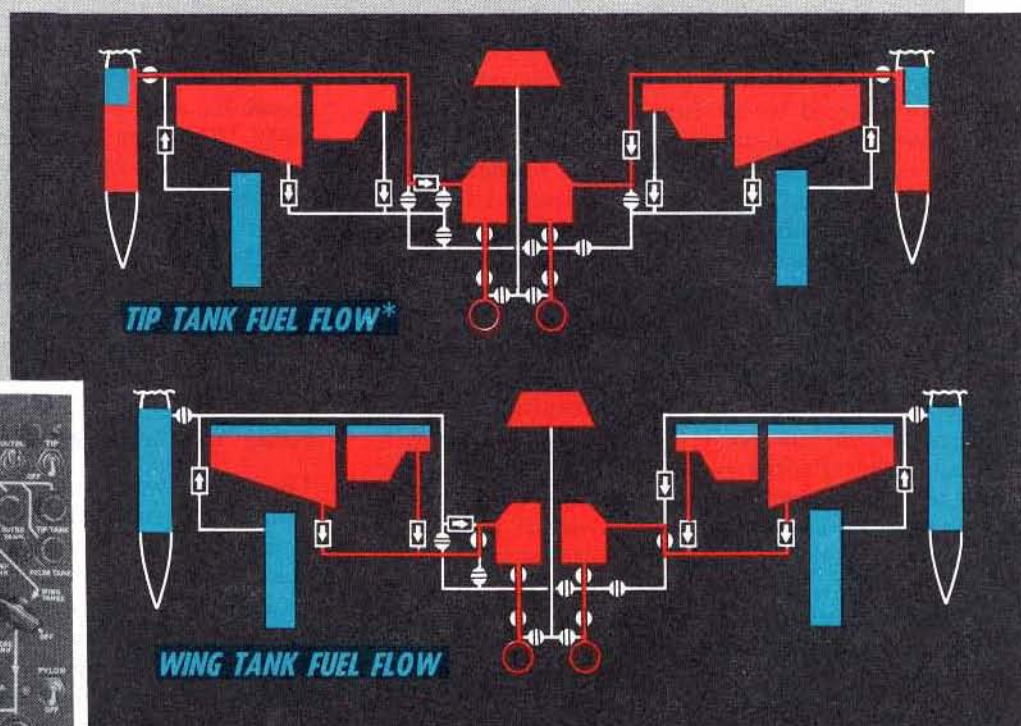
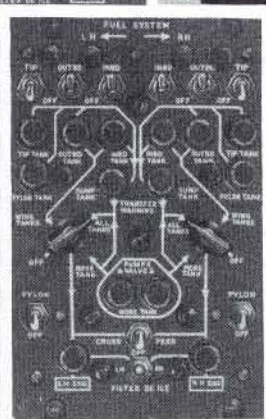
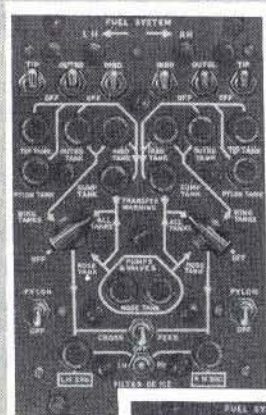
to the engine whose sump tank is low on fuel. The nose tank also is ready to feed the other engine when the other sump fuel reaches the preset low level. When the sump tanks empty, the nose tank feeds fuel to both engines as long as the fuel supply lasts. When the fuel in any tank is consumed, the tank warning light comes on and the tank switch should be turned to OFF. When the wing tanks are nearly empty, both warning lights come on to indicate empty wing tanks; however, fuel will continue to be pumped at a reduced rate for about 5 minutes if the wing tank switches are left at ON. If pylon or tip tank fuel does not feed during normal sequencing, the corresponding tank switch should be turned to OFF; this starts the next tank feeding. See figure 7-1 for fuel flow during normal sequencing.

Pylon Tank Normal Operation.

The fuel flows from the pylon tank to the sump tank and then to the engine. When the pylon tank empties, the pylon tank empty float switch closes the pylon tank fuel line and air pressure line, turns on the warning light, and starts the tip tank feeding. If the pylon tank is jettisoned before it is empty, the same action results. If the pylon tank loses air pressure because of tank damage or malfunction of the vacuum relief valve, the tank empty light will not come on; however, on Groups 1 and 5 airplanes, the fuel transfer warning light will indicate that fuel transfer has been interrupted. On Group 10 and subsequent airplanes, interruption of fuel transfer will be indicated by the sump tank low level warning light coming on. Placing the pylon tank switch at OFF brings the tip tank into sequence. Pylon tank fuel does not show in the fuel quantity gage system.

Fuel-Rocket Pod Tip Tank Normal Operation.

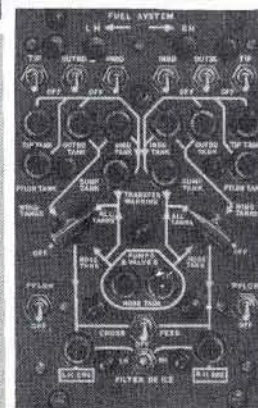
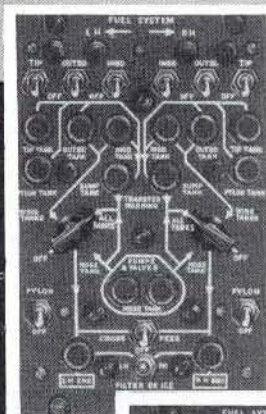
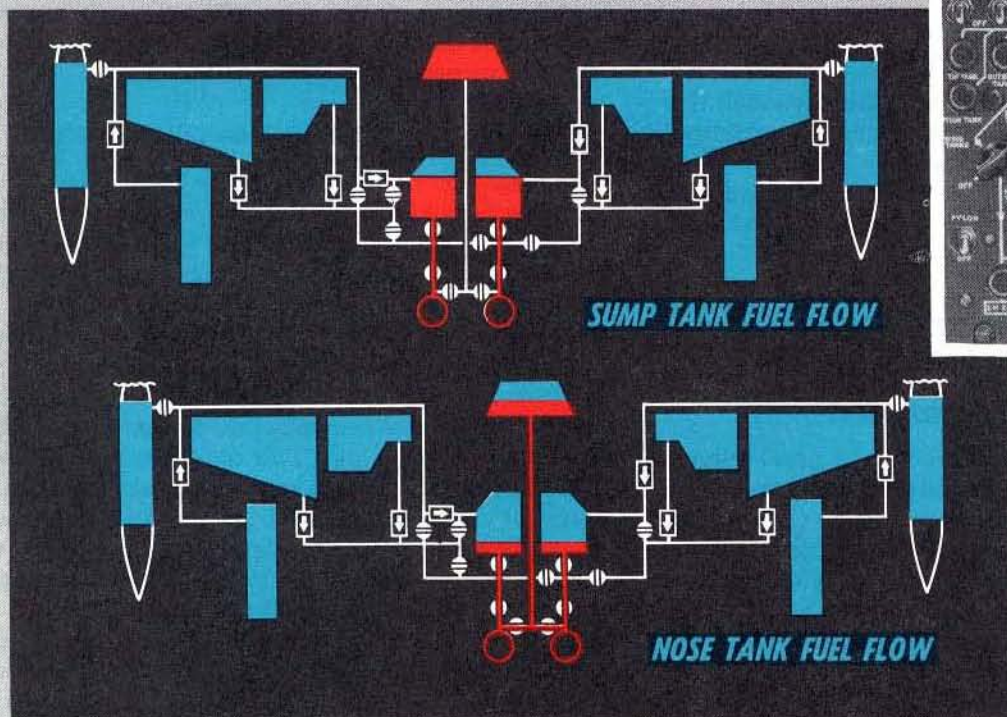
Tip tank fuel flows to the sump tank in much the same manner as pylon tank fuel (figure 7-1). When the tip tank empties normally, or fuel is dumped, the tip tank empty warning light comes on and both wing tanks start feeding the sump tanks automatically. If fuel remains in the tank because of air pressure failure or tank damage, that fuel is lost. At low altitudes, the fuel transfer rate from the pylon tank or tip tank may be less than engine demand at maximum power (100% rpm with afterburning). This condition will normally exist only for a minute or two during takeoff and early stages of climb, and, on Groups 1 and 5 airplanes, will cause the transfer warning lights to come on until the gain in altitude reduces the rate of fuel consumption to less than the rate at which the sump tank is being replenished. If the transfer warning light comes on and stays on while the engines are operating at military power before takeoff roll is started, takeoff should be delayed until the trouble is corrected. On Group 10 and subsequent airplanes, sump tank replenishment may be checked by turning the fuel quantity gage selector



● Fuel ● Emptied Fuel Space

NORMAL FUEL SEQUENCING

(GROUPS 1 THROUGH 70 AIRPLANES)



*PYLON TANK FUEL FLOW IS SIMILAR TO TIP TANK FLOW.

Figure 7-1.

switch to SUMP and then checking for a drop in sump tank fuel. When climbing with maximum power and operating from pylon tanks or tip tanks, the pilot should not permit the sump tank fuel to drop to the level that will cause the nose tank to feed out of sequence (before pylon, tip tank, and wing fuel have been used). This condition, evidenced by the sump low level lights coming on, is to be avoided because of a weight and balance consideration that will affect the airplane's handling characteristics. If either sump low level light comes on while operating the engines at maximum power, the related afterburner should be shut down. If the sump low level warning light does not go out within a few seconds, fuel transfer from the affected tank has been interrupted, and action must be taken to bring the next tank into sequence to replenish the sump tank; for as long as the sump low level warning light continues to burn, it indicates that the nose tank is also feeding the engine. This condition may be further verified by observing the nose tank fuel quantity gage.

Note

Single-point fueling circuit breakers must be pushed in for the tip tank to feed, because it is through these circuit breakers that the tip tank fuel valves receive power required for opening and closing.

Wing Tanks Normal Operation.

After pylon tank and tip tank fuel is exhausted, both the inboard and the outboard wing tanks (simultaneously) feed the sump tank (figure 7-1). When the wing tank booster pumps start operating, the wing tank warning lights will flash on momentarily. The lights will burn steadily if the booster pumps fail or the tanks become empty. When the inboard tank is nearly empty the outboard tank is still half full. However, neither tank warning light will burn steadily until both tanks on a side become empty. Because of the relatively flat wing tanks, the pumps can pick up residual fuel for about 5 minutes after the lights come on; then the wing tank switches should be turned to OFF.

Note

Momentary flashing of the inboard wing tank empty warning light can be expected to occur when the inboard wing tank is approximately empty during the transfer of fuel from both wing tanks to their sump tank.

Sump Tank and Nose Tank Normal Operation.

When the wing tanks are empty, the fuel in the sump tanks is pumped to the engines (figure 7-1). When the fuel level in a sump tank falls to the two-thirds full

point (63 US gallons remaining), both nose tank booster pumps start and pump fuel directly to the corresponding engine. When the fuel in the other sump tank falls to the two-thirds point, the nose tank feeds the other engine also. With sump tank and nose tank feeding either or both engines, afterburning can be used as long as the corresponding sump tank contains fuel.

Note

Because of booster pump pressure variations that may exist between the nose tank and the sump tank booster pumps, the sump tank fuel may be exhausted before the nose tank begins to feed fuel to the engines during normal sequencing.

Nose Tank Normal Operation (Sump Tank Empty).

When a sump tank empties, the nose tank alone will continue to feed the corresponding engine (figure 7-1). After all the fuel has been used from either the right or left main systems and the fuel gage shows that a sump tank is nearly empty, select NOSE TANK with the corresponding fuel selector switch, because selecting NOSE TANK will close the sump tank fuel outlet shutoff valve. This will allow the engine to draw fuel out of the nose tank by suction if the nose tank booster pumps fail. If an empty sump tank shutoff valve were open and both nose tank pumps were to fail, a flame-out would result from the engine drawing air through the empty sump tank. The other engine would be similarly affected when its sump tank emptied unless that tank's shutoff valve were closed by turning the fuel selector to NOSE TANK. When the nose tank is feeding both engines and both sump tanks are empty, both engines can be operated at 100% rpm without afterburning if both nose tank booster pumps are running. If both engines are feeding from the nose tank and one engine is idling, the other engine can use afterburning provided that it is developing a minimum of 90% rpm.

Nose Tank (Pumps and Valves) Warning Lights.

If a nose tank (pumps and valves) warning light (figure 1-19) is on when the nose tank is brought into sequence by the sump tank (or by manual selection), the light may mean either the failure of the corresponding nose tank shutoff valve to open, or the failure of the corresponding nose tank booster pump to start. To determine which malfunction is indicated, make the following check:

1. Crossfeed switch—ON.
2. If the light goes out, the corresponding nose tank shutoff valve has failed in the closed position, but the engine will continue to receive fuel from the opposite system through the crossfeed line.

3. If the light remains on, the corresponding nose tank booster pump is inoperative. The other pump will continue to supply fuel at a reduced rate, but at a rate sufficient to maintain two-engine military power at all altitudes.

If a nose tank valve has failed in the closed position, it is still possible to route fuel to the corresponding engine by leaving the crossfeed valve open and opening the nose tank valve to the other engine (by manual selection of NOSE TANK or by automatic selection when the sump tank fuel drops to 63 US gallons remaining). (See figure 1-16.)

FUEL SYSTEM MANUALLY SELECTED OPERATION

Wing Tanks Manually Selected Operation.

When necessary, the fuel in the wing tanks can bypass the sump tanks (figure 7-2) and feed directly to the engines. When the fuel selector switch is at WING TANKS and both wing tank switches are at ON, power is cut off from the sump normal booster pump; however, the sump-to-engine fuel line remains open so that afterburning can be used as long as fuel remains in the sump tank. When the sump tank empties, afterburning will stop without warning. If fuel remains in the sump tank after the wing tanks are empty, the fuel will gravity feed at low altitudes. When the wing tank booster pumps start operation, the wing tank warning lights should flash on momentarily until booster pump pressure builds up. If the pressure drops, because of a pump failure, the light will come on and remain on.

Nose Tank Manually Selected Operation.

Either fuel selector switch can be turned to NOSE TANK (figure 7-2) to start both nose tank booster pumps feeding fuel directly to an engine. If both selector switches are turned to NOSE TANK, the nose tank fuel will feed both engines. When the fuel in the nose tank drops to 188 US gallons, the 10 percent fuel reserve warning light comes on.

Note

When nose tank fuel is being used, the center of gravity travels toward the aft limit. After rockets have been fired, the weight of the nose tank fuel is essential to keep the airplane's center of gravity within the allowable limits until all of the wing tank fuel and part of the sump fuel has been used.

CROSSFEED OPERATION.

One Engine Inoperative.

The crossfeed line connects the two fuel systems so that, in single-engine operation, both fuel systems

can supply the operating engine (figure 7-2). For this operation the crossfeed switch must be at ON. (Refer to Single-Engine Procedure, Section III.)

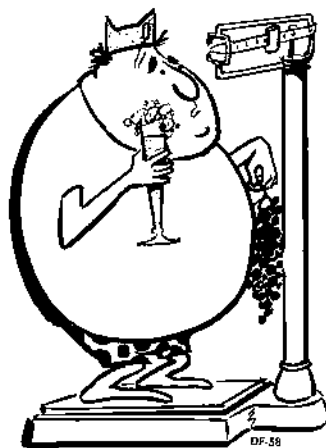
One Fuel System Empty.

If one fuel system becomes empty, the selector switch should be at ALL TANKS and the crossfeed switch at ON so that the other fuel system can feed both engines.

CAUTION

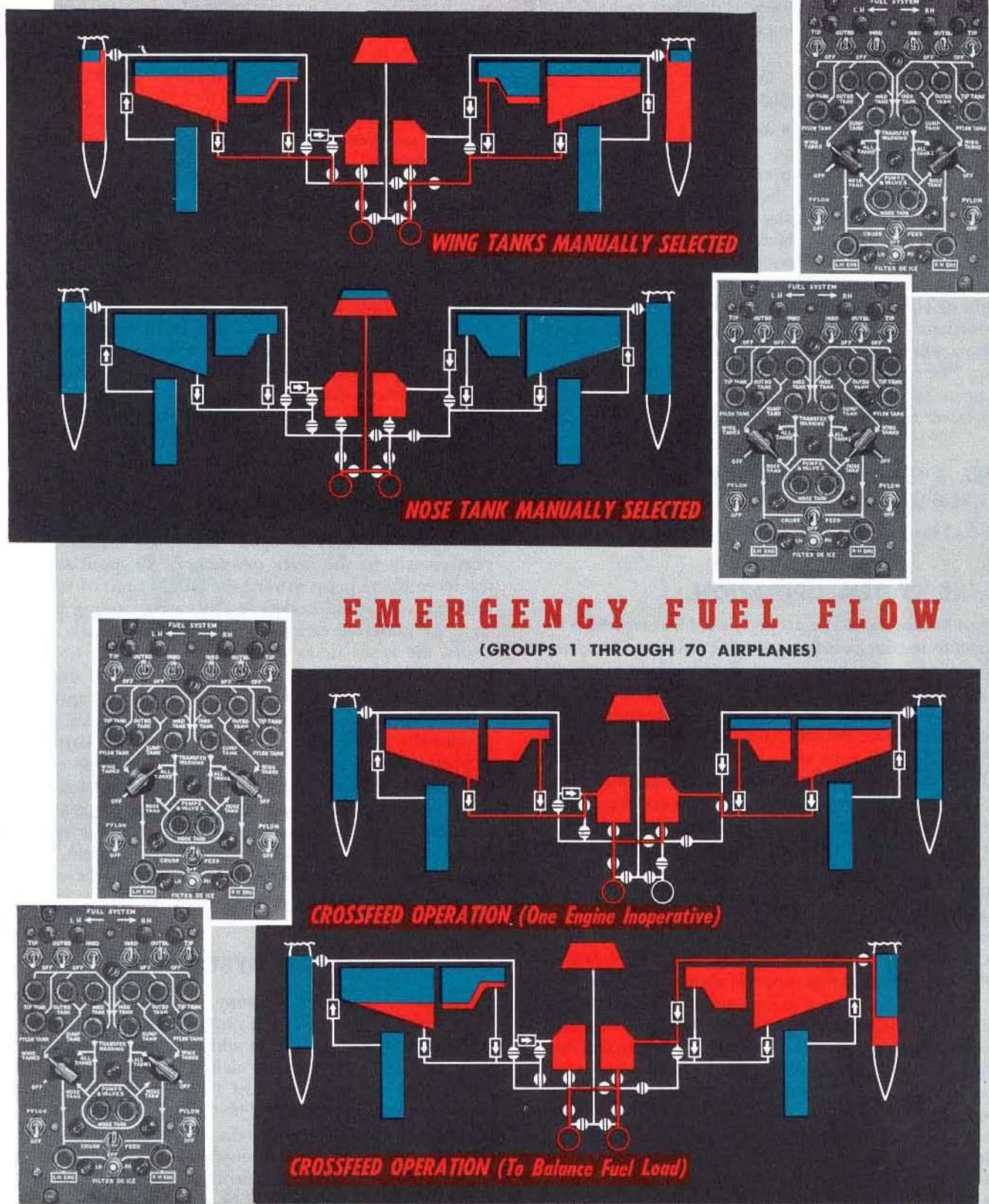
Do not turn the fuel selector switch for the empty fuel system to OFF, as the firewall valve to the corresponding engine will close and isolate that engine from its fuel supply regardless of the position of the crossfeed switch.

Balancing Fuel Load.



The fuel system crossfeed can be used to balance the fuel load (figure 7-2). The simplest method is to feed both engines from the system having more fuel (the heavier side), until the fuel quantity gages show even distribution or the airplane trims laterally as desired. Use the following procedure:

1. Fuel quantity gages—Check quantities in individual tanks by turning fuel gage selector switch as desired to obtain individual tank quantity readings on the gage indicators.
2. Crossfeed switch—ON.
3. Fuel selector switch (for the side with less fuel)—WING TANKS (this shuts down the sump tank booster pump).
4. Wing tank pump switches (for the side with less fuel)—OFF.



D-102 (1)

Figure 7-2.

5. Continue feeding from heavy side until tank quantities equal low side. When fuel load is balanced (or the airplane trimmed laterally as desired) fuel selector switch—ALL TANKS; wing tank switches—ON; cross-feed switch—OFF.

TIP TANK FUEL DUMPING.

When the tip tank dump button (on the fuel accessory control panel, figure 1-20) is pushed momentarily, both tip tank dump valves open simultaneously and are held open by a time-delay relay for 75 seconds. Air pressure from the normal tip tank pressure line forces fuel out the dump port (at the aft end of the tip pod cone) at a rate that normally will empty a full tip tank in approximately 60 seconds (in level flight or climb). If required, a new dumping cycle can be initiated by again momentarily pressing the dump button when the dump valve closes at the end of the first 75-second interval. Tip tank fuel cannot be dumped completely in a steep dive, and will dump at a lower than normal rate during rapid deceleration.

FUEL SYSTEM OPERATION (GROUP 75 AIRPLANES).

For fuel flow see figure 7-3 and figure 7-4.

BRAKE SYSTEM OPERATION.

Wheel brakes should be properly used and treated with respect to reduce maintenance difficulties and accidents due to wheel brake failure. Brakes should not be dragged when taxiing and should be used as little as possible for turning the airplane on the ground. Extreme care should be used to prevent locking a wheel and skidding the tires when applying brakes immediately after landing when there is considerable lift on the wings. Proper brake action does not occur until the tires are carrying heavy loads. Heavy brake pressure can result in a locked wheel far more easily if brakes are applied immediately after touchdown than if the same pressure is applied after the full weight of the airplane is on the wheels. Brakes can stop a wheel from turning, but stopping the airplane is dependent on the friction of the tires on the runway. Skidding resulting from improper braking tears off shreds of rubber that act as rollers between tire and runway; the heat generated by skidding melts tire rubber and the resultant molten rubber acts as a lubricant between tire and runway. The full landing roll should be utilized to minimize the use of wheel brakes and to take advantage of aerodynamic braking. Using either normal or emergency braking systems, short landing rolls (executed only when necessary) are accomplished by a single, smooth application of brakes with constantly increasing pedal pressure. To allow sufficient time for cooling between brake applications, a 15-minute interval is required between full stop landings where the landing gear remains extended in the slipstream and 30 minutes

between full stop landings where the gear has been retracted. If the brakes are used for steering or cross-wind taxiing, or if a series of landings is performed, additional time for cooling is required. When the brakes are in a heated condition resulting from excessive use in an emergency stop, the airplane should not be taxied into a crowded area and the parking brake should not be set. Peak temperatures occur from 5 to 15 minutes after a maximum braking operation and proper brake cooling procedure should be followed to prevent brake fire and possible wheel assembly explosion.

WING FLAP OPERATION.

The wing flap lever can be pre-positioned at UP, TAKE-OFF, or DOWN; and the flaps will move to the selected position. For intermediate positions, the lever must be held at the desired position until the indicator shows the flaps to be in that position. The lever can then be released and the flaps will remain in position until the lever is moved.

SPEED BRAKE OPERATION.

The speed brake lever opens the speed brakes proportionately to the lever movement. Pre-positioning the lever at any point toward the OPEN limit of travel will stop the speed brakes in the corresponding position. At indicated airspeeds up to approximately 260 knots, the speed brake surface can be opened to any position (from 0 degrees to 120 degrees included angle). At indicated airspeeds above 260 knots, the angle to which the speed brakes open will be decreased proportionally to the increase in airspeed. If the airspeed is great enough, the airflow creates a back pressure in the system and the speed brakes will "blow back" to the point where the back pressure on the actuating cylinders is equal to that of a relief valve in the speed brake hydraulic line. As the airspeed decreases, the speed brakes open to the original position if there has been no change in the position of the speed brake lever.

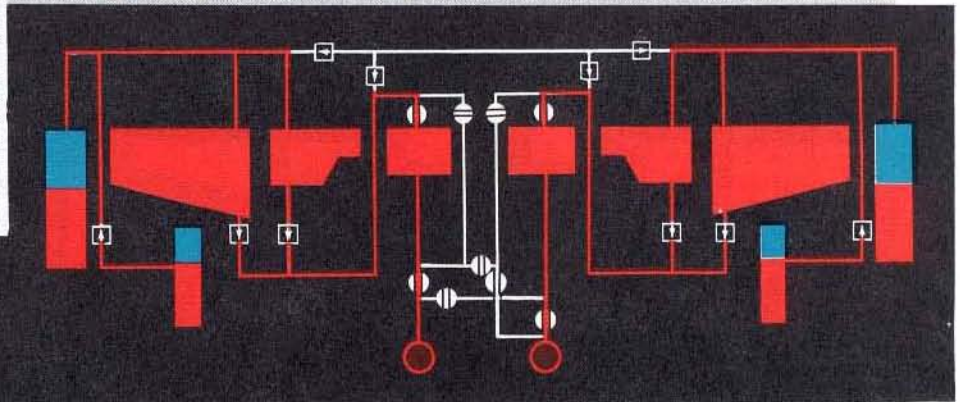
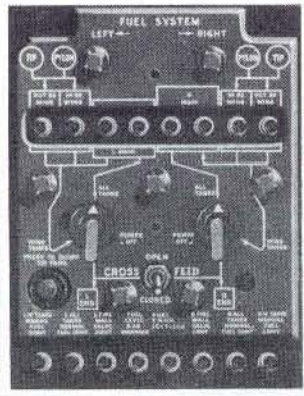
CANOPY JETTISON SYSTEM.

To properly jettison the canopy, a minimum pressure of 1400 psi is required in the canopy jettison air bottle. The decrease in temperature which accompanies high-altitude flight may cause the air bottle pressure to drop below 1400 psi. A pressure of 1800 psi when the ambient temperature is 100°F (38°C), will assure a minimum pressure of 1400 psi if the temperature decreases to -50°F (-46°C). To determine the required pressure at other ambient temperatures, subtract 40 psi from 1800 psi for each 15°F (8.4°C) increment below 100°F (38°C). For example, the required pressure for an ambient temperature of 70°F (21°C) would be 1720 psi.

NORMAL FUEL SEQUENCING

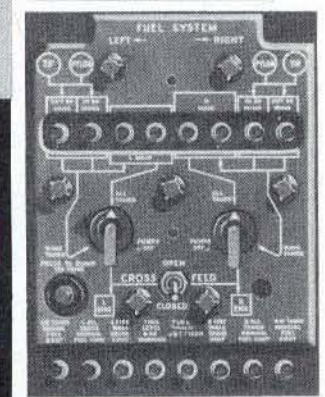
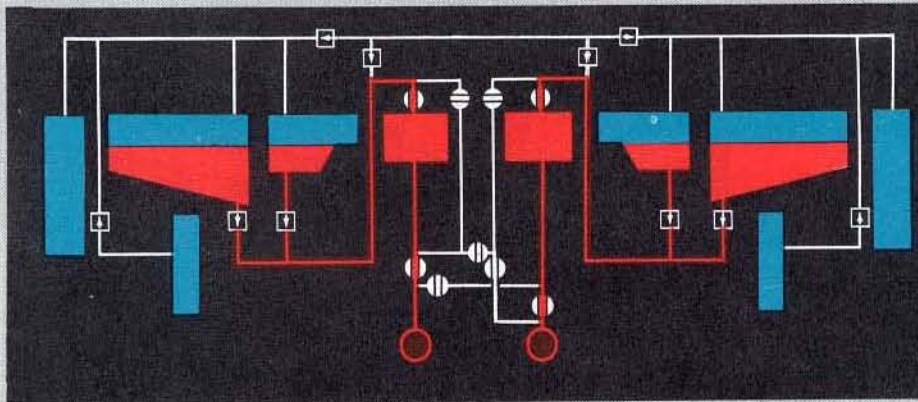
(GROUP 75 AIRPLANES)

TIP AND PYLON TANKS FUEL FLOW

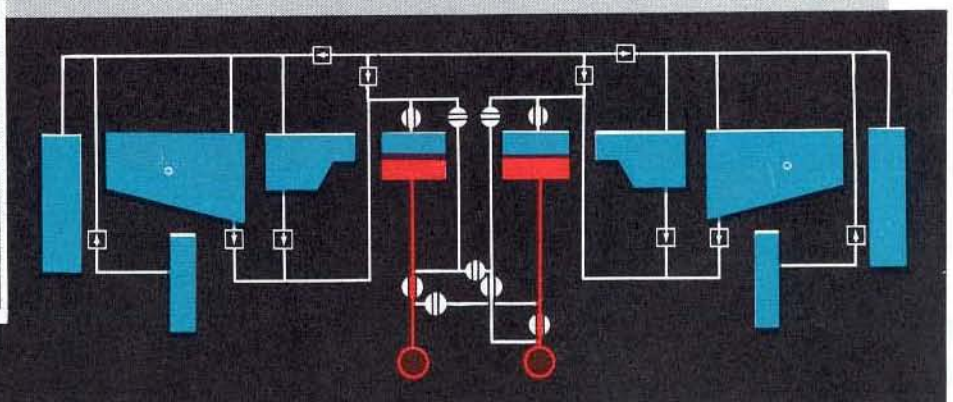
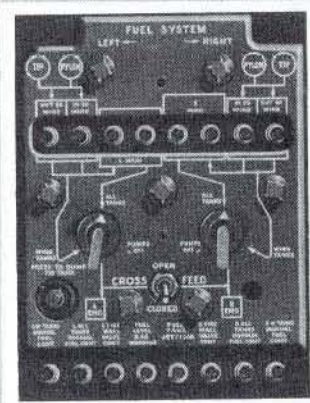


● Fuel ● Emptied Fuel Space

WING TANKS FUEL FLOW



MAIN TANKS FUEL FLOW



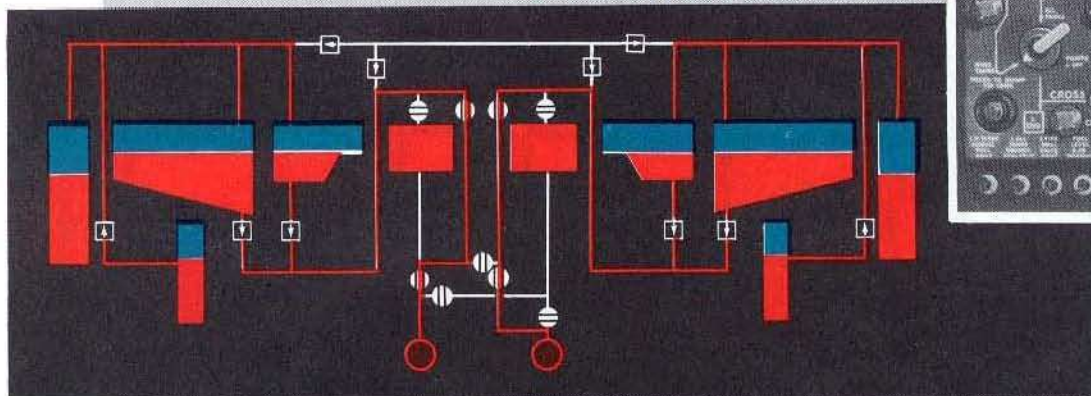
D-101(2)

Figure 7-3.

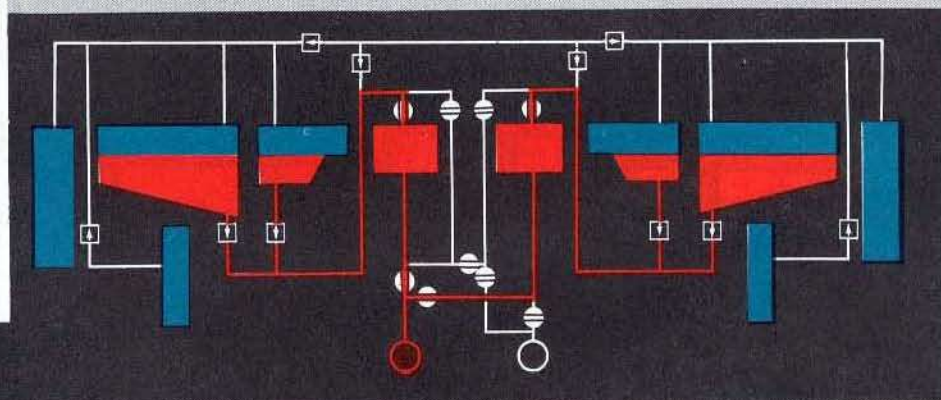
EMERGENCY FUEL FLOW

(GROUP 75 AIRPLANES)

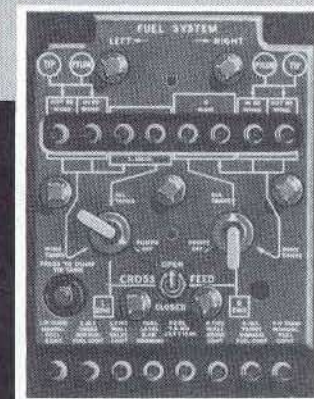
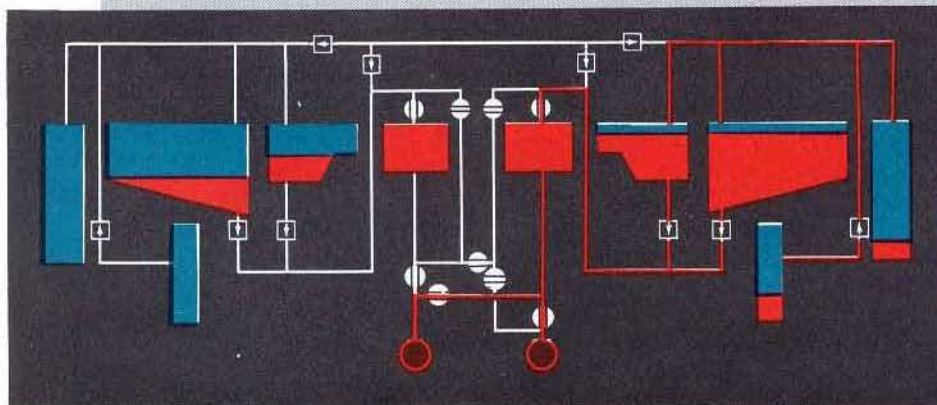
WING TANKS MANUALLY SELECTED



CROSSFEED OPERATION (One Engine Inoperative)



CROSSFEED OPERATION (To Balance Fuel Load)



D-102(2)

Figure 7-4.



Section VIII

CREW DUTIES

DF-8

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PILOT'S DUTIES.

The duties of the pilot have been covered thoroughly in other sections of this handbook and will not be repeated here.

RADAR OBSERVER'S DUTIES.

The radar observer's primary duty is to operate the radar equipment; therefore, he must be on every mission in which the radar equipment will be used. In addition to operating the radar equipment, he reads all checklists to the pilot and performs other important duties which are covered in the following paragraphs.

Note

For information regarding radar and armament refer to Section IV.

EXTERIOR INSPECTION.

At the discretion of the pilot, the radar observer will assist in making the exterior inspection (figure 2-2).

BEFORE ENTERING COCKPIT.

1. Ejection seat—Check:

Armrests and trigger stowed; safety belt initiator ground safety pin removed; safety pins installed; catapult file mark aligned.

Note

If the safety belt initiator ground safety pin is installed (at preflight inspection time), maintenance personnel should be consulted as to the status of the ejection seat.

ON ENTERING COCKPIT.

Note

A radar observer's checklist is located on the radar observer's instrument panel.

INTERIOR CHECK.

Rear Cockpit.

WARNING

If the C-2A life raft is being carried, the A-5 seat cushion should not be left on the seat. If both are used and it becomes necessary to eject or crash land, severe injury to the back may result due to the excessive compressibility of the combination of life raft and cushion. If additional height in the seat is needed, a solid filler block may be used in conjunction with the life raft.

1. Safety belt and shoulder harness—Fasten; inertia reel operation—Check; automatic-opening parachute lanyard—Connected.

2. Alternator external power switch—CLOSE (after external power is connected).

3. Interphone amplifier switch—ON.

4. Circuit breakers—IN, except left and right rocket test circuit breakers—OUT.

5. Interior light switches—As necessary.

6. Canopy defog knob—IN.

7. Altimeter and clock—Set and cross-check with pilot.

8. Canopy jettison pressure gage—Check pressure.

9. Interphone selector switch—MIX. SIG. & COM-MAND (COMM INTER); interphone toggle switch—INTER.

10. Communications equipment—Check operation.

11. Emergency signal system—Check (with pilot).

12. Armament switch—Check.

13. Oxygen regulator diluter lever—NORMAL OXYGEN; supply lever—ON.

14. Oxygen equipment—Check operation. (Refer to OXYGEN SYSTEM, Section IV, for detailed operation.)

15. Hydraulic engine hoist and brake selector valve handles—Handle B (aft) to NEUTRAL and handle A (forward) to SYSTEM.

16. Hydraulic handpump handle—Stowed.

17. Flashlight—Check operation (if required).

GROUND TESTS.

Check 115-volt a-c electrical system as follows:

1. Alternator exciter switch and alternator circuit

breaker switch—CLOSE (left engine rpm above 60%).

2. Voltage—Check alternator voltmeter for desired readings.

BEFORE TAKEOFF.

1. Ejection seat ground safety pins—Remove.

2. Safety belt—Tighten; shoulder harness—Adjust to fit snugly; inertia reel lock lever—LOCKED.

3. Anti "G" suit valve button—Press to check operation.

DURING FLIGHT.

1. Adjust radar controls for set operation, refer to Section IV for detailed instructions.

CAUTION

If the fire control system was on at any time during flight, the fire control system master switch should not be turned to the DISCONN. position until the airplane is landed and parked.

BEFORE LANDING.

During approach to the field, check safety belt and shoulder harness for tightness, and lock inertia reel lock lever. Before manually moving the entire radar console assembly to the forward position, place the viewing scope in the stowed position.

BEFORE LEAVING AIRPLANE.

1. All switches—OFF.
2. Ejection seat ground safety pins—IN.



CONDENSED CHECKLIST

CUT ON DOTTED LINE

F-89D CONDENSED CHECKLIST

(Radar Observer)

Note

The following checklist is a condensed version of the radar observer's duties and is accomplished by the radar observer.

EXTERIOR INSPECTION.

At the discretion of the pilot, the radar observer will assist in making the exterior inspection (figure 2-2).

BEFORE ENTERING THE COCKPIT.

1. Ejection seat—Check.

INTERIOR CHECK.**REAR COCKPIT.**

1. Safety belt and shoulder harness—Fasten; inertia reel operation—Check; automatic-opening parachute lanyard—Connected.
2. Alternator external power switch—CLOSE (after external power is connected).
3. Interphone amplifier switch—ON.
4. Circuit breakers—IN, except left and right rocket test circuit breakers—OUT.
5. Interior light switches—As necessary.
6. Canopy defog knob—IN.
7. Altimeter and clock—Set and cross-check with pilot.
8. Canopy jettison pressure gage—Check pressure.
9. Interphone selector switch—MIX, SIG. & COMMAND (COMM INTER); Interphone toggle switch—INTER.
10. Communications equipment—Check operation.
11. Emergency signal system—Check (with pilot).
12. Armament switch—Check.
13. Oxygen regulator diluter lever—NORMAL OXYGEN; supply lever—ON.
14. Oxygen equipment—Check operation.

T.O. 1F-89D-1
20 June 1957

1

CONTINUED ON NEXT PAGE

CONDENSED CHECKLIST

CUT ON DOTTED LINE

T.O. 1F-89D-1
20 June 1957

1. All switches—OFF.
2. Ejection seat ground safety pins—IN.

BEFORE LEAVING AIRPLANE.

1. Safety belt and shoulder harness—Check for tightness.
2. Inertia reel lock lever—Lock.
3. Viewing scope—Stowed.
4. Radar console assembly—Forward position.

BEFORE LANDING.

1. Adjust radar controls for set operation.

DURING FLIGHT.

1. Ejection seat ground safety pins—Remove.
2. Safety belt—Tighten; shoulder harness—Adjust to fit snugly; inertia reel lock lever—LOCKED.
3. Anti "G" suit valve button—Press to check operation.

BEFORE TAKEOFF.

1. Alternator exciter switch and alternator circuit breaker switch—CLOSE (left engine rpm above 60%).
 2. Voltage—Check alternator voltmeter for desired readings.
- Check 115-volt a-c electrical system as follows:

GROUND TESTS.

15. Hydraulic engine hoist and brake selector valve handles—Handle B (aft) to NEUTRAL; and handle A (forward) to SYSTEM.
16. Hydraulic handpump handle—Stowed.
17. Flashlight—Check operation (if required).

2



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The procedures in this section pertain only to all-weather operation and are in addition to the normal procedures in Sections II and IV.

INSTRUMENT FLIGHT PROCEDURES

INTRODUCTION.

Flying the airplane in instrument weather conditions requires instrument proficiency and thorough pre-flight planning. In planning IFR flights, remember that fuel requirements for completion of instrument letdown approach procedures and possible diversion to alternate fields must be added to that normally required for VFR flights. Therefore, maximum range or endurance of the airplane, if required to land in IFR weather conditions, is reduced accordingly. The airplane has good stability characteristics and flight handling qualities for weather flying. At times when the cg position is aft of the normal position, the elevator stick force is light and elevator control must be applied cautiously. This condition is most

likely to be encountered when all fuel is expended except approximately 400 pounds in the sump tanks and all but 500 pounds or less in the nose tank. For ease of handling, banks should be limited to 30 degrees unless maximum rate turns are ordered by GCI during interceptions. The flight computer installation greatly simplifies precision instrument flying. Pilots should avoid any tendency, however, to concentrate exclusively on the flight computer indicator, or to be hypnotized by it. Concentration on the indicator alone, particularly during rollout from turns, may cause a temporary sense of vertigo. When using the flight computer, monitor the action of the airplane with the basic standard flight instruments at all times to be sure that the airplane follows the flight path set up on the flight computer controls.

INSTRUMENT TAKEOFF AND INITIAL CLIMB.

Instrument takeoffs can be satisfactorily made with or without afterburners. However, afterburning is recommended to shorten the takeoff roll in conditions of low visibility and when takeoff in crosswind is made. Heading must be maintained with brakes (until rudder becomes effective) on airplanes not equipped with nose wheel steering. Make instrument takeoffs at normal VFR speed. See figure 9-1 for typical instrument takeoff with flight computer.

Note

Use the flight computer for takeoff and cross check with all flight instruments to determine proper attitude.

CAUTION



Check altimeter, vertical velocity indicator, and airspeed indicator to ensure positive climb and acceleration.

Note

Do not use course indicator (ILS localizer) horizontal bar to maintain pitch attitude during takeoff and initial climb.

1. Climb to approximately 2000 feet at best angle of climb, then climb at airspeed shown on Climb Chart, figure A-9.

Note

Approximately 5 degrees of roll error may appear on the attitude indicator on accelerated turn after takeoff. This error will be in the direction of the turn and should disappear within a short time.

2. Trim for hands-off flight.

Note

Maximum adjustment of the pitch trim knob on the flight computer provides 20-degree nose-up pitch with the horizontal bar of the flight computer zeroed (centered). This pitch limit is sufficient for IFR climbs at best climbing airspeeds.

3. Anti-icing switch—FLIGHT if necessary.

INSTRUMENT CLIMB.

Make typical flight computer climb as shown in figure 9-2.

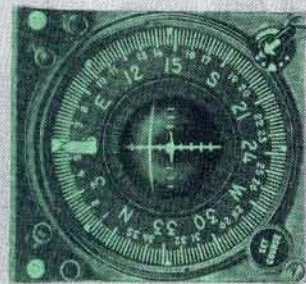
INSTRUMENT CRUISING FLIGHT.

Keep the airplane trimmed for hands-off flight and use the flight computer with the altitude control on. Maintain altitude by holding the horizontal bar of the flight computer centered.

URNS.

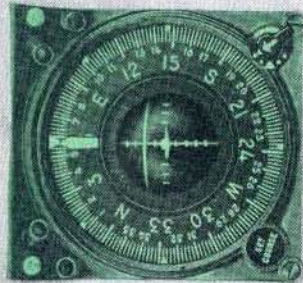
The attitude indicator is the only direct reading instrument for pitch and bank changes. Turn errors occur in both its pitch and bank indications. Consequently, the vertical velocity indicator and the altimeter must be cross-checked with the attitude indicator to maintain altitude in turns. When rolling out of a turn, the flight computer heading pointer and the turn needle must be observed in conjunction with the attitude indicator to return to straight flight. This is because the attitude indicator may indicate a slight wing-down condition for a short time even though the airplane is in level flight. The gyro will precess back to a correct indication in a short time. The maximum bank angle required to zero or center the vertical bar of the flight computer during turns is set at 30 degrees regardless of airspeed and altitude. Banks of more than 30 degrees may be made with reference to the flight computer by holding the vertical bar at one or more dots beyond center. At high altitudes, when making steep turns in level flight, buffeting may be expected. The maximum amount of heading change to right or left that should be selected at a time is approximately 150 degrees. Example: If steering a heading of 360 degrees and a right turn of 180 degrees is desired, rotate the heading selector to the right until the double needle reaches 150 degrees, or until the vertical bar starts to swing in the opposite direction. Start turn, and when at least 30 degrees of this turn has been completed, rotate the heading selector to 180 degrees and continue the turn. The flight computer will start a rollout indication 22 degrees before the selected heading is reached.

INSTRUMENT TAKEOFF WITH FLIGHT COMPUTER (Typical)



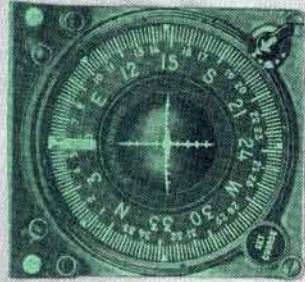
2 TAKEOFF

- Taxi into position and make visual lineup on center of runway.
- Set course dial on flight computer indicator to coincide with runway heading.



3 GROUND ROLL

- Maintain direction by holding vertical bar on zero.



4 LIFTOFF AND INITIAL CLIMB

- Lift the airplane off the runway in normal

manner and zero the horizontal bar. The two dots fly-up setting will automatically provide a safe and efficient takeoff and initial climb to a safe terrain altitude.

note

When using the flight computer cross-check with basic flight instruments.

1 BEFORE TAKEOFF

- Flight Computer selector switch — FLIGHT INST.

note

If taking off with the aid of a localizer, set selector switch at (VOR-LOC) RIGHT if taking off on the approach heading, or set it at (VOR-LOC) LEFT if taking off on the reciprocal of the approach heading. When taking off on the approach heading, expect vertical bar oscillation when passing over localizer transmitter at the end of the runway.

- Set horizontal bar of flight computer indicator at two dots fly-up signal.

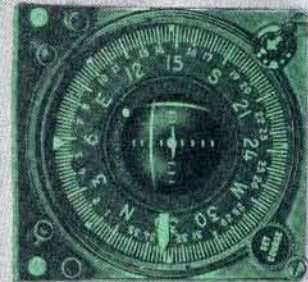


Figure 9-1.

CLIMB WITH FLIGHT COMPUTER (Typical)

1 INITIAL CLIMB

At a safe terrain altitude (approximately 2000 feet above ground), lower nose slightly and accelerate to best climbing airspeed.

2 CLIMB

Establish desired angle of climb and adjust horizontal bar to zero with the pitch trim knob.

3

Keep horizontal bar zeroed at best climbing airspeed by reducing the speed by reducing the pitch trim as necessary during climb to altitude.

note

When using the flight computer, cross-check with basic flight instruments.

4 LEVELING OFF

When the desired altitude is reached, turn altitude control switch to ON and zero the horizontal bar. Return the pitch trim knob to neutral (horizontal) position.

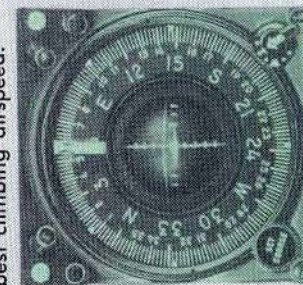
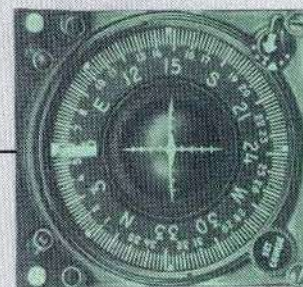
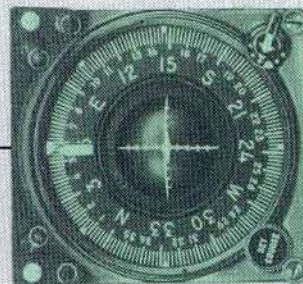
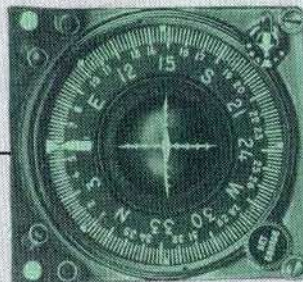
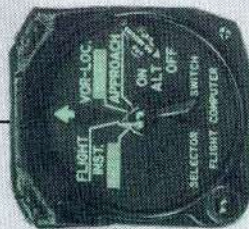


Figure 9-2.

Note

If more than 150 degrees of heading to right or left is selected, an opposite turn or roll indication will be presented.

See figure 9-3 for typical flight computer turn procedure.

IFR LOITERING AND RADIO/OMNIRANGE HOLDING.

For best loitering indicated airspeeds (fuel-wise) depending on altitude and weight of the airplane, refer to Maximum Endurance Charts (figures A-14 and A-20) in Appendix I. A good approximate airspeed for all conditions is 200 knots IAS. When making turns during IFR loiter at these reduced airspeeds, add power as necessary to hold the recommended IAS. If airspeed is allowed to fall off, an excessive amount of power is required to hold altitude, thus increasing fuel consumption.

IFR INTERCEPTIONS.

With sufficient practice, interceptions can be performed under instrument conditions without difficulties. With proper coordination between pilot and radar observer, the pilot can perform the attack phase of the interception under instrument conditions, using the attitude indication and target information on his radar scope. Use of the flight computer for principal flight reference greatly simplifies instrument flight during ground control phase of interceptions. When given vectors by the GCI controller, turn the flight computer heading selector to the corresponding heading and roll immediately into the turn to center the vertical bar on the indicator. Keep the airplane trimmed while tracking the target, particularly when decelerating after lockon.

Note

Use the windshield wiper in precipitation to increase visual sighting range after lockon.

INSTRUMENT DESCENTS.

The optimum power (fuel-wise) for descents is idle rpm. If icing conditions are probable, the descent should be made with sufficient power to provide adequate hot air for the anti-icing system. For maximum ease of handling, a constant-speed letdown is recommended. The optimum speed brake position depends on the IAS and rate of descent combination desired. The adjustable speed brakes make possible various rates of descent at the same IAS. Example: It is possible to descend 2000 feet per minute, 3000 feet per minute, 4000 feet per minute, and 5000 feet per minute at 200 knots IAS by adjustment of the speed brakes. Maximum adjustment of the pitch trim knob

on the flight computer provides a 10-degree nose-down pitch with the horizontal bar of the flight computer zeroed (centered). This pitch limit is sufficient for normal IFR descents. For descents in excess of 10 degrees, horizontal bar deflection in dots above the zero or center position can be used for holding constant pitch angles. Descending turns at high rates of descent and airspeed become progressively more difficult to control as bank angles are increased over 30 degrees. Therefore, bank angles in turns should normally be limited to approximately 30 degrees during rapid descents. No difficulty will be encountered when using the flight computer zeroed inasmuch as it limits bank to 30 degrees. Satisfactory instrument descents near a navigational aid or radio fix can best be achieved by using 85% rpm, extending the landing gear, and controlling airspeed with the speed brakes. Descents from 40,000 feet to normal traffic altitude will take approximately 5 minutes.

Note

The windshield and canopy defrost system should be operated at the highest temperature possible (consistent with the pilot's comfort) during high altitude flight in order to provide sufficient preheating of the transparent surfaces to preclude the formation of frost or fog during descent.

See figure 9-4 for typical flight computer descent procedure.

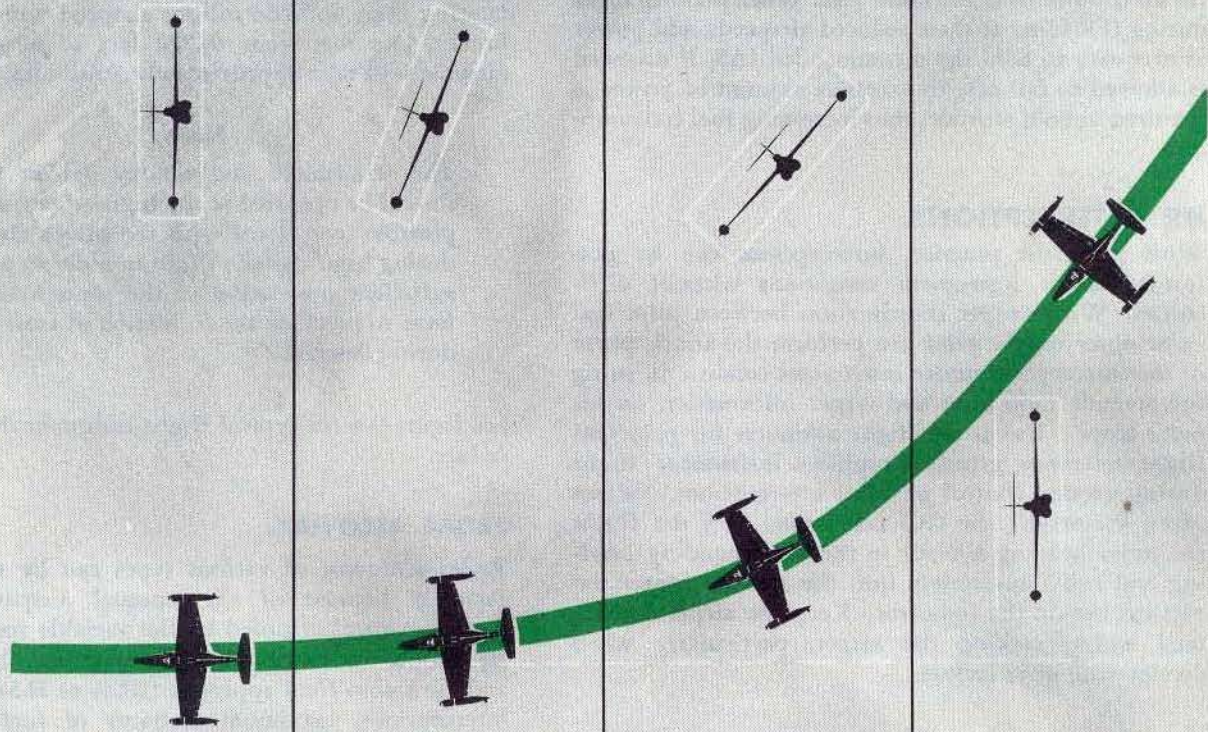
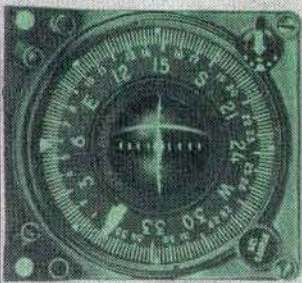
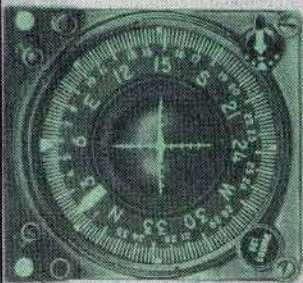
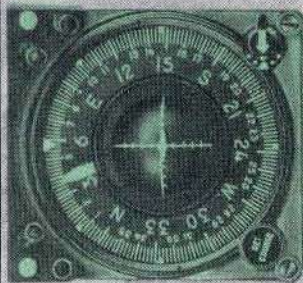
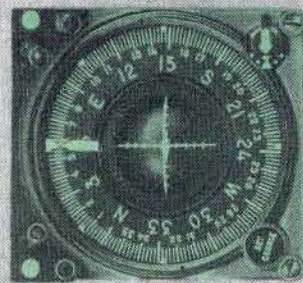
RADAR RECOVERY.

Radar letdowns of various types can be made satisfactorily because of the unusual airspeed rate-of-descent control afforded by the variable speed brakes. By proper radar control techniques for the letdown and turn onto final approach (GCA or ILS) following interceptions, maximum economy of fuel and time can be realized. Keep the airplane trimmed for hands-off flight and use the flight computer. Radar recovery procedures to be used following interceptions in weather should be practiced in VFR and IFR weather to develop and improve the teamwork of the pilot and radar controller. When a GCA or ILS approach is required, the descent, from the inbound cruising altitude, should be started at a sufficient distance to permit a straight-in descent at the recommended constant indicated airspeed plus approximately 3 miles for deceleration and changing to approach configuration before reaching the turn-on point (gate) to final approach.

RADIO/OMNIRANGE JET PENETRATIONS (LETDOWNS).

Various techniques can be used for radio/omnirange jet penetrations. Penetrations with or without gear and

TURNS WITH FLIGHT COMPUTER (Typical)



4

The airplane is on the new course and the heading pointer coincides with selected course.

3

Keep the vertical bar zeroed. (Note that the heading pointer is approaching the selected course at the top of the indicator dial.)

2

Zero the vertical bar.

1

Set the course dial on the flight computer indicator to the new heading. The vertical bar of the indicator will be deflected in the direction the turn is to be made.

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Figure 9-3.

DESCENT WITH FLIGHT COMPUTER (Typical)

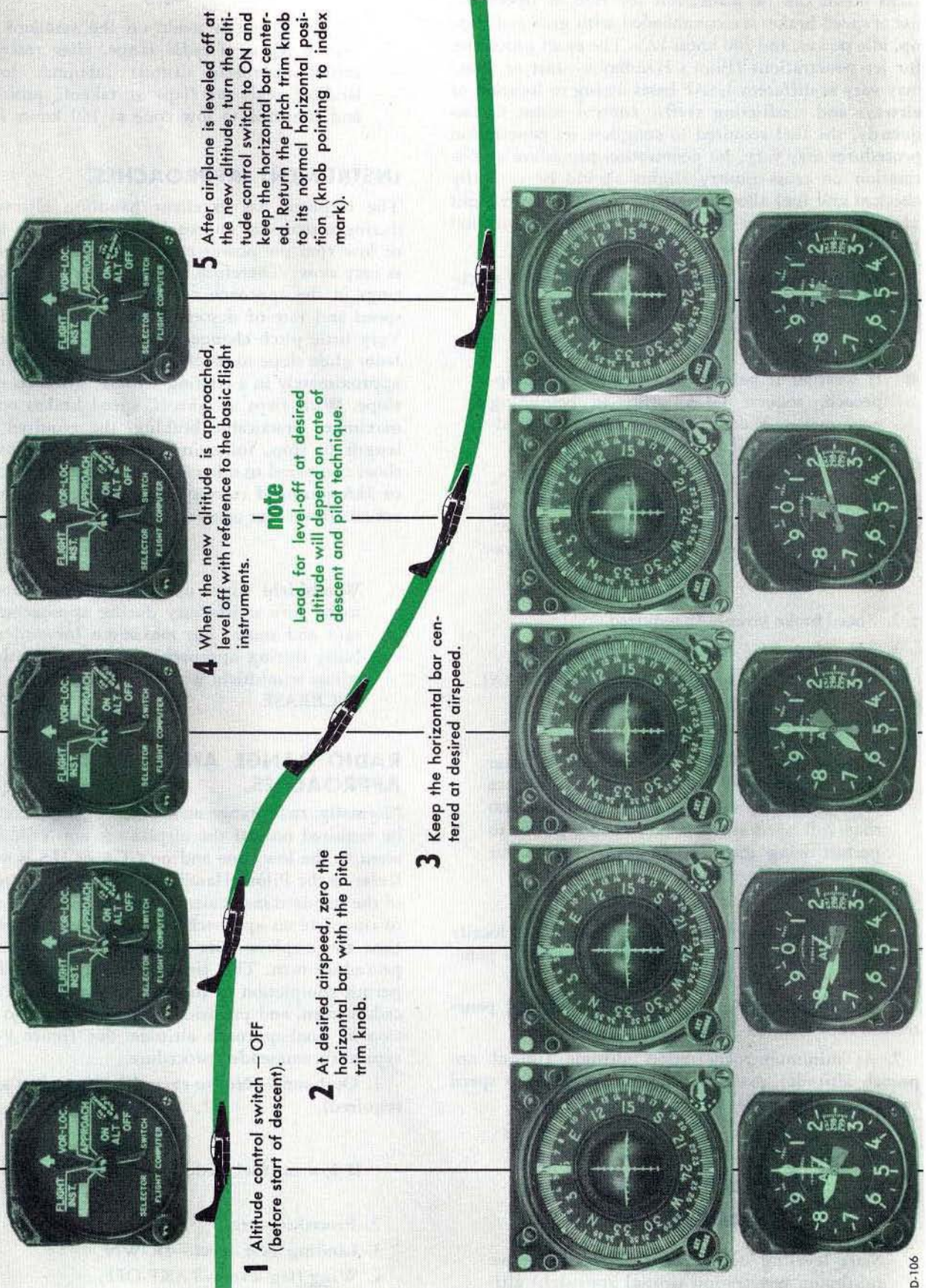


Figure 9-4.

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flaps down can be made, but for ease of operation, use of speed brakes is recommended with gear and flaps up, idle power, and 200 knots IAS. The exact procedure for jet penetrations (Pilot's Handbook—east or west) may vary at different USAF bases owing to location of airways and conflicting traffic control zones. Consequently, the fuel required to complete jet penetration procedures may vary. Jet penetration procedure at destination on cross-country flights should be carefully checked and fuel allowances made as part of preflight planning. See figure 9-5 for a typical jet penetration procedure.

1. Maintain initial penetration altitude until reaching the radio fix.

Note

- If weather is below minimum for range approach, request GCA prior to beginning penetration. Make decision to proceed to alternate while still at altitude.
 - ADF penetrations using homing beacons can be executed with the same basic techniques and procedures as radio/omnirange penetrations.
2. Speed brake lever—As required.
 3. Throttles—85% rpm.
 4. Windshield de-ice and defog knob—NORMAL.

Note

With a single airplane, descent can be made with speed brakes full open. With airplanes in flight formation, the leader must use less than full open speed brakes at idle power to permit wing men use of speed brakes for maintaining formation.

5. On outbound leg, descend one-half (or as locally prescribed) of the vertical distance to minimum penetration altitude at 250 knots IAS.
6. Use flight computer to make a descending penetration turn.
7. At minimum penetration altitude (initial approach altitude), maintain 200 knots IAS with speed brakes closed (approximately 85% rpm).

WARNING

Start leveling out at least 1000 feet above minimum penetration (initial approach) altitude by closing the speed brakes.

Note

If penetration is made on the standard approach leg of a radio range, after reaching initial approach altitude inbound: lower landing gear, set flaps at takeoff position, and continue to low cone at 160 knots IAS.

INSTRUMENT APPROACHES.

The airplane has excellent handling characteristics during instrument approaches. When power is at idle or low rpm the power response to throttle movement is very slow. Therefore, use relatively high power settings in the approach configuration, and control airspeed and rate of descent by using the speed brakes. Very little pitch change is required during transition from glide slope to touchdown, because the airplane is approximately in a landing attitude while on the glide slope. With flaps at takeoff, speed brakes open, and maximum practicable braking, the required runway length to stop, following instrument approaches, is short compared to other jet fighters. A 6500-foot GCA or ILS equipped runway is considered minimum for actual all-weather operations.

Note

Windshield wiper operation has been found to be very satisfactory during approaches in rain and snow. For maximum forward visibility during approaches in such conditions, adjust windshield wiper speed rheostat to full INCREASE.

RADIO RANGE AND OMNIRANGE APPROACHES.

Normally, radio range and omnirange approaches will be required only if the airplane is not VFR after descent to the low cone and no GCA or ILS is available. Refer to the Pilot's Handbook for the local procedures of the standard instrument approach. The fuel required to complete an approach is largely determined by the time the airplane flies outbound before making the procedure turn. This time need only be sufficient to permit completion of the cockpit check after the procedure turn, and precision beam following to the station at final-approach altitude. See figure 9-6 for a typical recommended procedure.

1. Outbound—Not to exceed 1 minute (or as locally required).

Note

If low on fuel, reduce time outbound.

2. Procedure turn.
3. Landing gear lever—DOWN.
4. Wing flap lever—TAKE-OFF.
5. Speed brake lever—CLOSED.

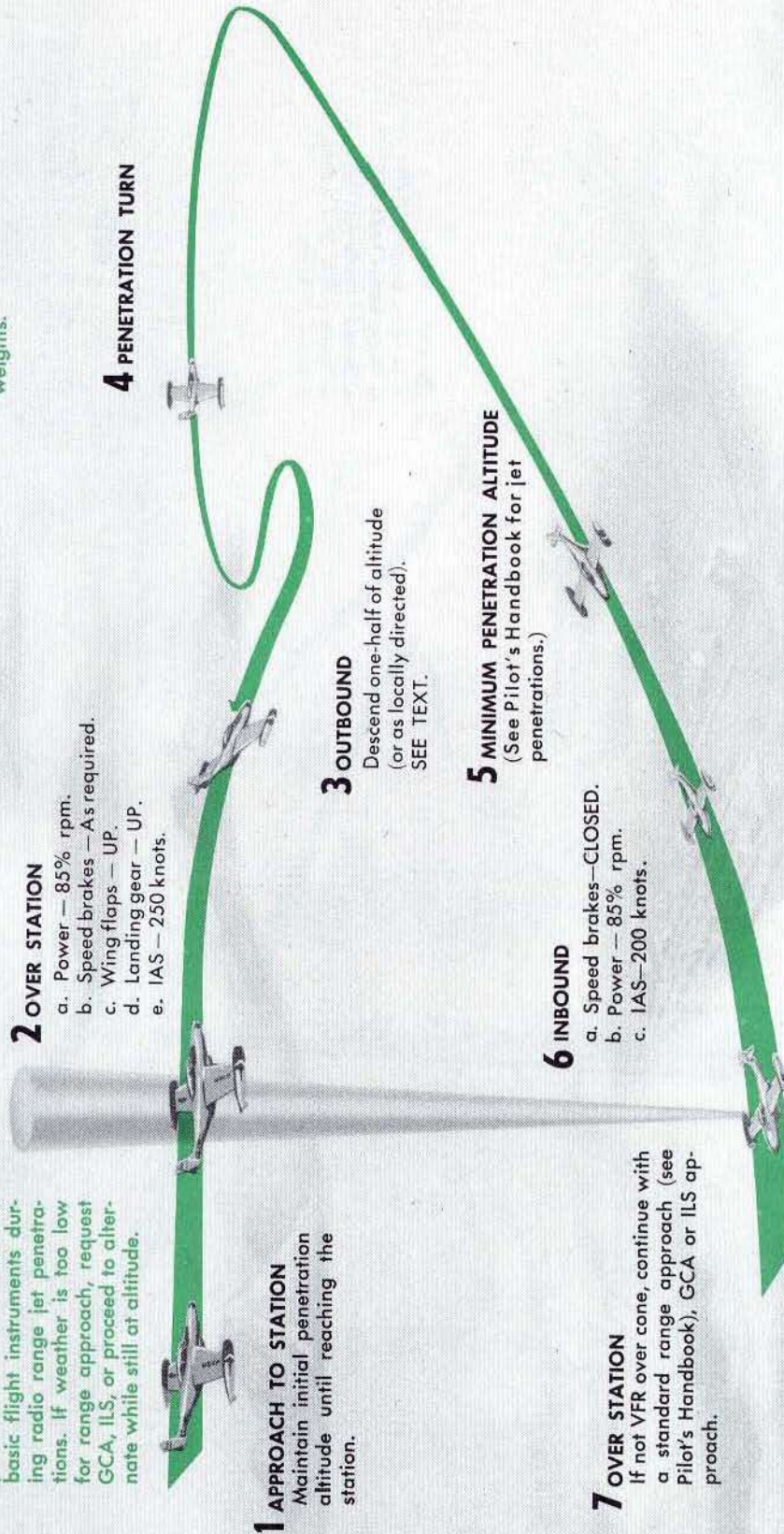
RADIO RANGE JET PENETRATIONS (Typical)

note

Refer to Pilot's Handbook for specific jet penetration instructions. Use the flight computer and cross-check with the basic flight instruments during radio range jet penetrations. If weather is too low for range approach, request GCA, ILS, or proceed to alternate while still at altitude.

note

Power settings other than IDLE $\pm$ 2% rpm to maintain IAS at all air temperatures and gross weights.



WARNING

Start leveling out at least 1000 feet above minimum penetration altitude by closing speed brakes and slowly adding power.

Figure 9-5.

RADIO RANGE APPROACH (Typical)

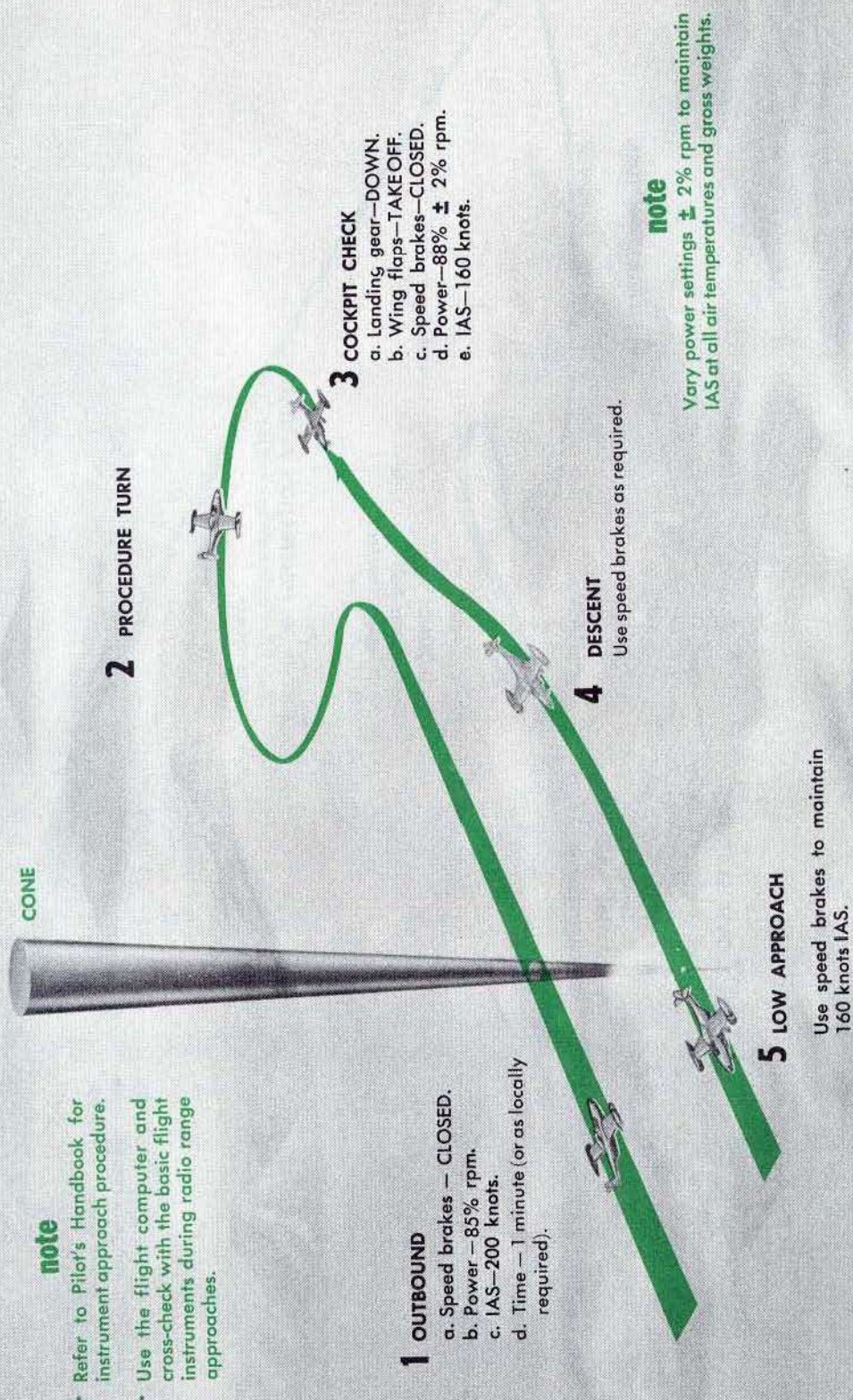


Figure 9-6.

6. Adjust throttle to maintain 160 knots IAS.
7. Low cone—Use speed brakes to establish required rate of descent.

GCA APPROACHES.

GCA approaches normally consist of a rectangular pattern beginning over a radio fix. Some USAF bases, ideally located in relation to radio range stations, employ modified versions of the basic GCA pattern. An example of this may be found in cases where the approach leg of the range station is also the final approach of the GCA pattern. Other bases may have still other variations of the basic rectangular pattern. Therefore, the fuel and time required for GCA approaches may vary at different USAF bases, depending on the local procedure. On IFR cross-country flights, the GCA procedure at the destinations should be checked and fuel allowances made as part of pre-flight planning. Emergency GCA approaches can be made with less fuel by requesting the GCA controllers to shorten the pattern. Fuel can also be conserved by delaying the cockpit check until on base leg or final approach, but prior to reaching the glide slope. On GCA approaches, use of the flight computer is not recommended because it is easier to use standard flight instruments for primary reference. Basic GCA pattern (see figure 9-7) is as follows:

1. Downwind leg—Maintain 200 knots IAS with landing gear and wing flaps up and speed brakes closed (approximately 85% rpm).
2. Landing gear lever—DOWN; visually check main gear down.
3. Wing flap lever—TAKE-OFF.
4. Maintain approximately 88% rpm.
5. Base leg—Reduce airspeed to 180 knots IAS with throttles.
6. Final approach—Maintain 150 knots IAS.
7. Glide slope—Use speed brakes (approximately one-half open) to maintain 150 knots IAS.

Note

- Fuel quantity, temperature, wind direction and velocity on glide slope will affect the speed brake setting necessary to maintain the desired rate of descent on the glide slope at 150 knots IAS. This setting, however, will be approximately one-half open.
 - During heavy precipitation, GCA operators may have some difficulty keeping the airplane visible in "clutter" on the scope, and the pilot may have to initiate a missed-approach procedure.
8. Touchdown—Speed brake lever to OPEN.

ILS—FLIGHT COMPUTER APPROACHES.

Check the Pilot's Handbook for local ILS procedure. The flight computer greatly simplifies the initial turn-on to the localizer as well as precision beam following on the localizer and glide slope. To use the flight computer the pilot must (1) select the proper heading, (2) select VOR-LOC RIGHT if inbound or VOR-LOC LEFT if outbound, (3) keep the indicator centered, (4) monitor the action of the airplane with the basic flight instruments, (5) monitor the ILS indicator to determine when the glide slope is reached, and (6) select APPROACH position of the flight computer selector switch. See figure 9-8 for a typical ILS approach with the flight computer.

ILS—AUTOPILOT-CONTROLLED APPROACH. (GROUP 35 AND SUBSEQUENT AIRPLANES).

Engage the autopilot and, using any standard approach, maneuver the airplane to intercept the localizer beam at approximately 45 degrees, 10 miles out, and at 1200 to 1500 feet above the terrain. (The allowable intercept angle is 45 degrees at 8 miles, increasing proportionally to 90 degrees at 13 miles.) Use the following general procedure to obtain consistently good results.

1. Approach to localizer—Lower flaps and landing gear, adjust power for 160 knots IAS, and check that both flags on the course indicator are down. Trim the airplane for approximately level flight at 1200 to 1500 feet above the terrain, and place the altitude switch at ON if desired.
2. Intercepting localizer—When the airplane enters the localizer beam, the vertical bar on the course indicator will leave its stop. As soon as this occurs, place the localizer switch at ON. The airplane will bracket the beam automatically.
3. Intercepting the glide slope—When the airplane enters the glide slope, the horizontal needle of the course indicator will approach the center of the meter. When the needle enters the top half of the small circle, set the approach switch at ON. The airplane will start down the beam automatically.
4. On the glide slope—Adjust flaps and speed for flareout and landing.

Note

At normal weights the final approach speed for autopilot-controlled approaches should be approximately 145 knots IAS.

5. Breakthrough or minimum altitude—Disengage the autopilot, complete flareout, and land manually.

MISSED-APPROACH GO-AROUND PROCEDURE.

1. Throttles—OPEN; use afterburners for acceleration if necessary, but consideration must be given to increased fuel consumption.

G C A A P P R O A C H (Typical)

note

If fuel is low maintain 200 knots IAS in clean configuration and complete cockpit check on base leg or immediately after turn on final.

note

Power settings $\pm 2\%$ rpm to maintain IAS at all temperatures and gross weights.

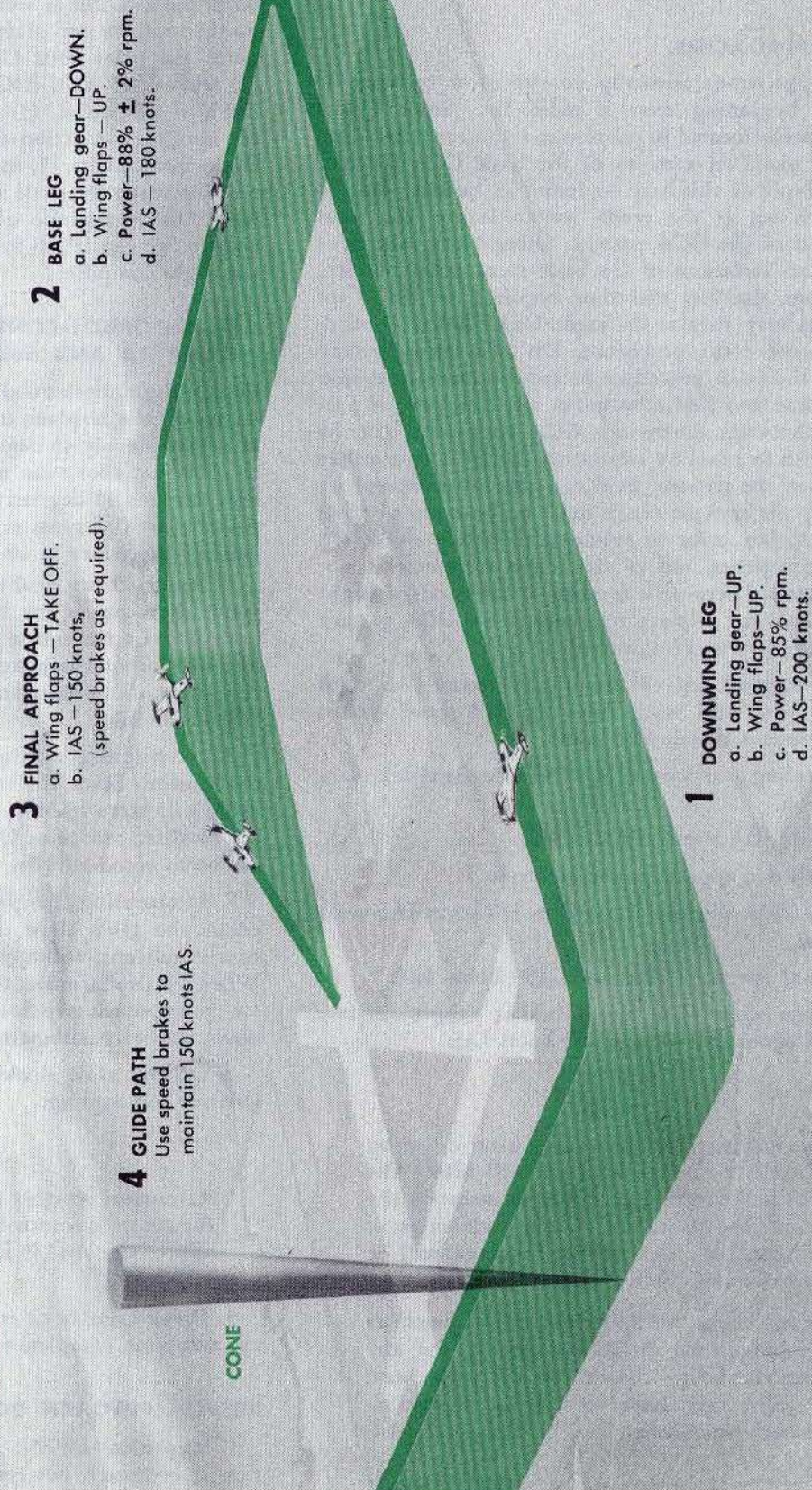


Figure 9-7.

ILS APPROACH WITH FLIGHT COMPUTER (Typical)

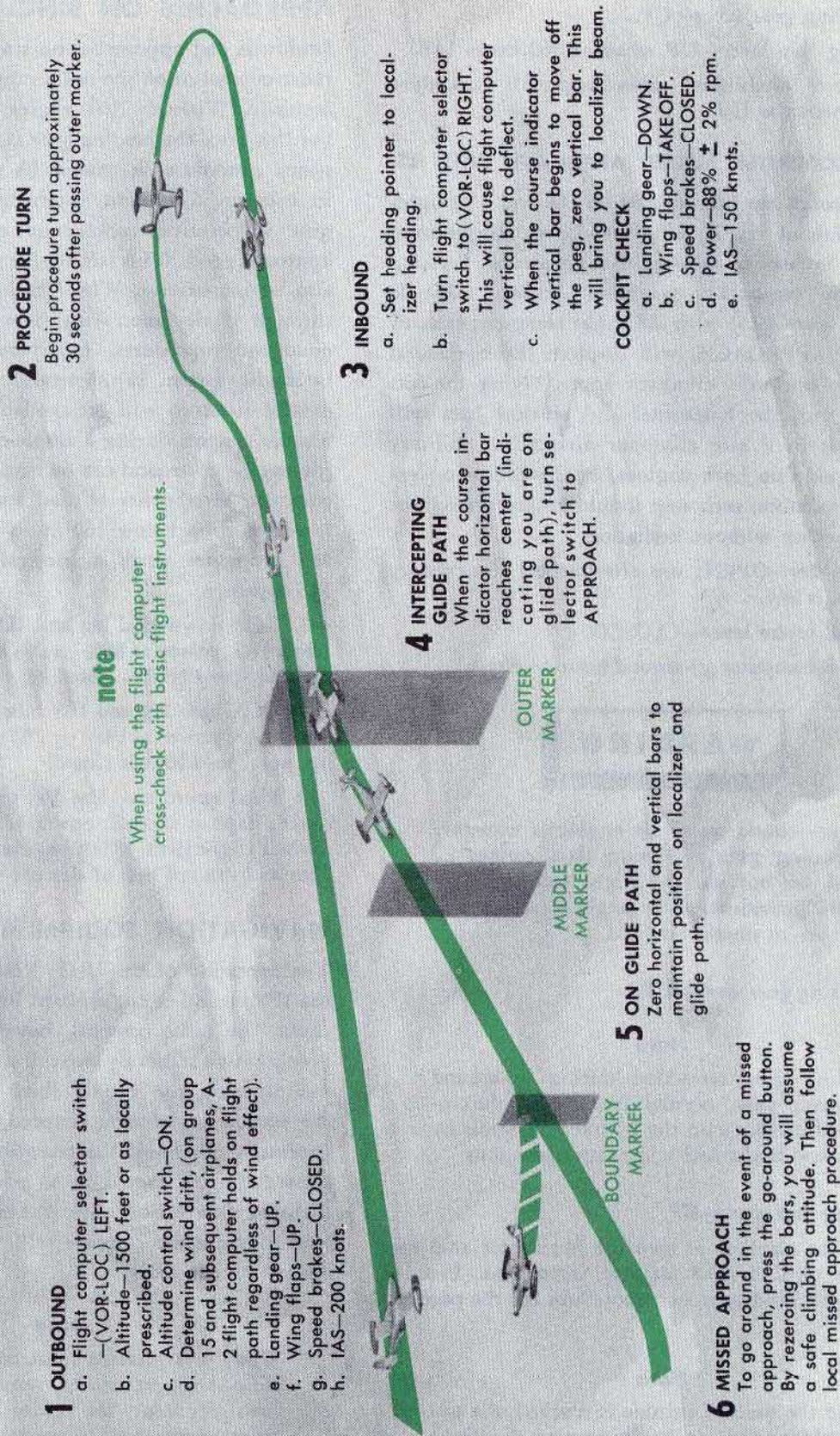


Figure 9-8.

2. Speed brake lever—CLOSED.
3. Landing gear lever—UP.
4. Wing flap lever—UP when at 160 knots IAS.
5. Execute established missed-approach procedure for the particular field.

FLIGHT COMPUTER MISSED APPROACH WITH ILS.

If an approach has been missed on ILS and a straight-ahead climbout can be safely made, the flight computer can be used to accomplish a go-around. Pressing the flight computer go-around button (altitude switch) (figure 4-15) with the flight computer selector switch at APPROACH, will displace the horizontal bar to the optimum climbout angle. Flying the airplane to zero the horizontal and vertical bars will then result in a safe climbout airspeed if military power is used on both engines. In the following go-around procedure, each step should be performed one after the other without hesitation.

1. Throttles—OPEN; use afterburners if necessary unless fuel is low.
2. Speed brake lever—CLOSED.
3. Flight computer go-around button—Press.

WARNING

If a go-around on single engine is necessary or landing gear and wing flaps cannot be raised, do not use the flight computer go-around procedure as the angle of attack will result in an unsafe airspeed.

4. Landing gear lever—UP.

Note

Landing gear retraction during go-around is slower than normal because of the increased demands on the hydraulic systems by the speed brake and wing flap operations.

5. Wing flap lever—UP.
6. Fly the airplane to zero the horizontal and vertical bars until desired altitude is reached. Execute established missed-approach procedure for the particular field.

Note

When the desired altitude is reached, the go-around feature is cut out by turning the flight computer selector switch from the APPROACH position.

INSTRUMENT LETDOWNS AND APPROACHES ON SINGLE ENGINE.

Letdowns and approaches on single engine, either by radar control or on the radio range, can be made satisfactorily. With the left engine inoperative, remember that once the landing gear is lowered by the emergency procedure, it cannot be retracted. Therefore, in making instrument approaches with the left engine inoperative, concentrate on making the first approach good. With left engine out, speed brakes will also be inoperative. Wheel brakes and, on Groups 1 through 35 airplanes, wing flaps must be operated by emergency procedures. On airplanes equipped with left hydraulic system supplemental pump, adequate hydraulic pressure will be available to operate all hydraulic systems during a single-engine approach. Single-engine go-around can be made with the gear down provided afterburner is used and airspeed is not allowed to drop below 160 knots IAS. Use the following procedure when making single-engine GCA or ILS approach:

1. GCA downwind leg and ILS outbound—Use 200 knots IAS, power at $86\% \pm 2\%$ rpm, gear down, flaps up, and speed brakes closed.
2. GCA base leg and ILS inbound—Use 160 to 170 knots IAS, power at $94\% \pm 2\%$ rpm, gear down, flaps up, and speed brakes closed.
3. Final approach—Use 160 to 170 knots IAS, gear down, flaps at takeoff, power as required to maintain desired flight path. If left engine is operative, use 98% rpm and control rate of descent with speed brakes.

NAVIGATION EQUIPMENT.

The operation of the UHF, VHF navigation set, and the IFF beacon is not affected by most weather conditions. The radio compass, however, is susceptible to precipitation static. By switching to the LOOP position and rotating the needle (bird dog) 90 degrees to the station or reducing airspeed, or changing altitude (normally climbing) the reception usually can be improved. Flights should be so planned and conducted, utilizing all available aids, that erratic or faulty operation of the radio compass will not become a serious emergency condition.

Note

When precipitation static completely muffles radio range reception, even after airspeed has been reduced, the radio compass needle pointer may still give reasonably accurate bearing to the station if left in the COMP position.



INTRODUCTION.

The thin wings and high speeds of jet airplanes can result in critical ice accumulation in relatively light icing conditions in those airplanes with the anti-icing systems inoperative. Surface icing can reduce IAS and range of the airplane considerably. Icing occurs when the supercooled water in fog, clouds, or rain impinges and freezes on the airplane surfaces. Normally the heaviest icing takes place in clouds with strong vertical currents (cumulus clouds, projections above stratocumulus clouds, etc). Icing conditions as found in stratus clouds are generally light to moderate; however, severe icing conditions may occur in this type of cloud. Prolonged flights through moderate icing can build up as much ice as a short flight through severe icing conditions. The most severe type of ice formation will generally occur above -5°C (23°F).

SURFACE ICING.

Surface icing normally occurs at temperatures near 0°C (32°F) on the outside air temperature gage. The anti-icing system will keep all heated surfaces clear of ice without noticeable loss of engine thrust. The system will also effectively de-ice the airplane if ice is allowed to accumulate on the wings and tail. The purpose of the system is to prevent formation of ice; therefore, use the system continuously whenever conditions indicate a possibility of ice. Refer to Section IV for operating instructions on the anti-icing systems.

WARNING

If the thermal anti-icing system is inoperative and any low level flying is to be performed under icing conditions, a higher than normal IAS should be used. Icing will cause the stalling speed to increase considerably; therefore extreme caution should be used, especially during takeoff, approaches, and landings.

ENGINE ICING.

Axial flow jet engines are seriously affected by icing. Engine air intake scoop anti-icing is controlled by the anti-icing switch and care must be taken to prevent ice buildup on these surfaces since ice ingestion by the engine can result in engine failure. Ice forms on the fixed inlet screens and compressor inlet guide vanes (stator) and restricts the flow of inlet air. This causes a loss of thrust and a rapid rise in exhaust gas temperatures. As the airflow decreases, the fuel-air ratio increases, which in turn raises the temperature of the gases going into the turbine. Complete turbine failure may occur in a matter of seconds after ice builds up in the engine air inlet. Critical ice buildup on inlet screens can occur in less than 1 minute under severe conditions. The idea that heating due to ram pressure at high speed will prevent icing is dangerous. The heat generated at subsonic speed is insufficient to prevent ice formation.

IN BELOW-FREEZING AIR TEMPERATURE.

The rate of engine icing for a given atmospheric icing intensity with outside air below freezing temperature is relatively constant up to an airspeed of approximately 250 knots TAS. Assuming constant icing conditions, the rate of icing increases with increasing airspeed above 250 knots. Therefore, a reduction of airspeed to a safe minimum will reduce the rate of engine icing in ambient temperatures of 0°C (32°F) or below.

IN ABOVE-FREEZING AIR TEMPERATURE.

Unlike surface icing, engine inlet icing can occur at temperatures above freezing. Because serious inlet duct icing can occur without the formation of ice on the external airplane surfaces, it is necessary to understand what causes this type of icing in order to anticipate it, if possible, so that immediate corrective action will be taken when positive indications of engine icing appear. When jet airplanes fly at velocities below approximately 250 TAS, and at high power setting, the intake air is sucked, instead of rammed,

into the engine compressor inlet. This suction causes a decrease in air temperature (adiabatic cooling). Under these conditions, air at a temperature above freezing may be reduced to subfreezing temperature as it enters the engine. Free moisture in the air may become supercooled and cause engine icing although no external surface icing is evident. The maximum temperature drop which can occur on most current engines is a drop of approximately 5°C (9°F). The greatest temperature drop occurs at high rpm on the ground and decreases with (1) decreasing engine rpm, and (2) increasing a. speed.

INDICATION OF ENGINE ICING.

The initial indication of engine icing is increased exhaust gas temperature. This is usually the only indication prior to complete engine failure. At the first sign of engine icing, turn on the engine anti-icing system immediately. Refer to Section IV for the operation of this system.

FLIGHT IN ICING CONDITIONS.

If a flight must be made in icing conditions, and if either the engine or surface anti-icing system is inoperative, observe the following precautions:

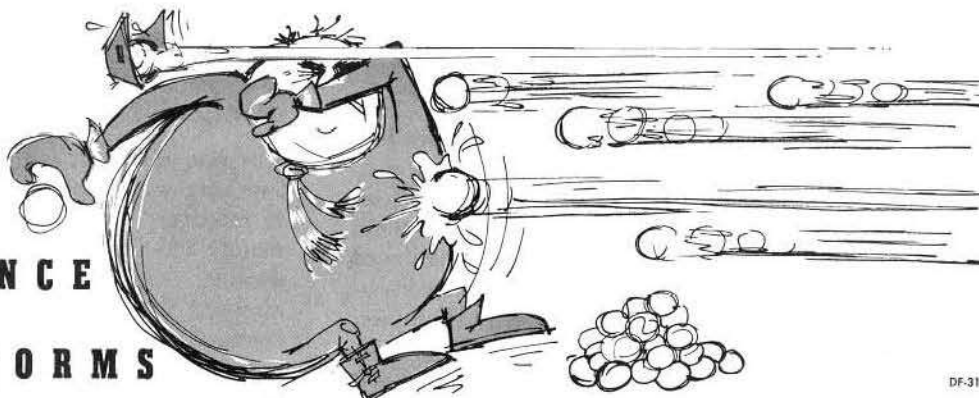
1. Avoid known areas of icing conditions. Many

areas of probable icing conditions can be avoided by careful flight planning and study of weather conditions.

2. If possible, avoid takeoff when the temperature is between -10°C (14°F) and 5°C (41°F), if fog is present, or the dew point is within 4°C or 7°F of the ambient temperature. These are the conditions under which engine icing can occur without surface icing. When freezing rain or other icing conditions exist at takeoff, the anti-icing switch should be placed at TAKE-OFF. The loss of thrust on takeoff is not noticeable to the pilot. Afterburners should be used to climb rapidly above the icing conditions.

3. If the ambient temperature is in the range of 0°C (32°F) to 5°C (41°F), the speed of the airplane should be maintained at 250 knots or above to lessen the possibility of inlet duct icing due to suction effect

4. If icing conditions are encountered at freezing atmospheric temperatures, immediate action should be taken as follows: change altitude rapidly by climb or descent in layer clouds, or vary course as appropriate to avoid cloud formations; reduce airspeed (in freezing air) to minimize rate of ice buildup; maintain close watch of exhaust gas temperature and reduce engine rpm as necessary to prevent excessive exhaust gas temperature.



DF-31

INTRODUCTION.

Altitudes between 10,000 and 20,000 feet are usually the most turbulent areas in a thunderstorm. If possible, thunderstorm flying should be avoided since this type of flight requires considerable instrument experience. Only pilots who have had considerable instrument experience should intentionally fly through a thunderstorm. However, thunderstorms cannot always be avoided, and the following procedures are for flying through thunderstorms encountered on routine flight.

Proper flight technique in turbulent air depends mainly on power setting and pitch attitude. The power setting and pitch attitude for the recommended penetration airspeed should be set before entering the storm. If these settings are maintained throughout the storm, airspeed will remain constant regardless of false readings and fluctuations on the airspeed indicator. At altitudes above 35,000 feet, sufficient power is not available to regain airspeed in level flight once it has dropped to about 200 knots IAS. If it is noted that airspeed is dropping below 200 knots IAS, lower

the nose slightly and maintain a descent of approximately 1000 feet per minute until airspeed is regained. Do not use afterburners in the storm as serious trouble could be encountered if the airplane inadvertently goes into a steep spiral. At 30,000-foot altitude or lower, once the throttle adjustment is made, airspeed control is not a problem and the most serious trouble to be encountered is severe turbulence and possible hail damage. In the storm, the airplane should not be maneuvered intentionally. However, by observing the recommended turbulent air penetration airspeed, a maximum maneuverability margin will be sustained at all operating gross weights without developing prohibitive load factors. In less severe turbulence there are no airspeed restrictions, but maneuvering should be restricted in proportion to the degree of turbulence.

BEFORE TAKEOFF.

Proceed as follows:

1. Analyze the general weather situation to determine thunderstorm areas and prepare a flight plan to avoid these areas if possible.

APPROACHING THE STORM.

If the storm cannot be seen, radio crash static will indicate that a storm is near; ground radar control or airborne radar may also be used to determine areas of less intensity in the storm. Prepare the airplane as follows before entering the storm:

1. Adjust power to obtain a safe and comfortable penetration speed of 200 to 275 knots IAS. If higher airspeeds are desired, do not exceed the following:

With <i>any</i> tip tank fuel	275 knots IAS
With <i>no</i> tip tank fuel	325 knots IAS

5. Flight computer altitude switch—OFF.
6. Safety belts (pilot's and radar observer's)—Tighten.
7. Turn off any radio equipment made useless by static.
8. At night, turn cockpit lights (and thunderstorm lights on Group 45 and subsequent airplanes) to full brightness.

IN THE STORM.

1. Do not allow turbulence and lightning to cause undue alarm; devote all your attention to flying the airplane.
2. Maintain power setting and pitch attitude set before entering the storm.
3. Maintain altitude and original heading insofar as possible. Concentrate mainly on holding a level attitude by reference to the artificial horizon. Use as little elevator control as possible to minimize the stresses on the airplane.
4. Do not chase the airspeed indicator, since doing so will result in extreme airplane attitudes, stall, or airspeed in excess of limits. Heavy rain may decrease the indicated airspeed reading considerably by partially blocking the pitot tube pressure head. The readings in this case will fluctuate more than in normal turbulence.
5. The altimeter may be unreliable in the thunderstorm because of different barometric pressures within the storm. An indicated gain or loss of several thousand feet may be expected. Make allowances for this error in determining minimum safe altitude.



APPROACHING THE STORM

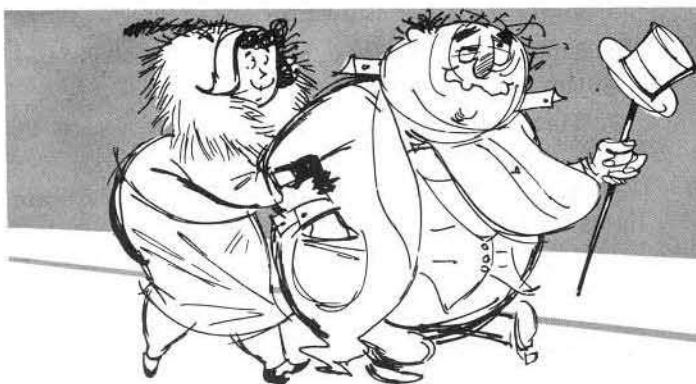
MAXIMUM SPEED
WITH ANY TIP TANK FUEL **275** KNOTS IAS

MAXIMUM SPEED
WITH NO TIP TANK FUEL **325** KNOTS IAS

DF32

2. Pitot heat switch—ON.
3. Anti-ice switch—FLIGHT; windshield de-ice and defog knob—NORMAL.
4. Flight instruments—Check.

6. In a thunderstorm area, least turbulence is usually encountered at an altitude above the terrain between zero and 6000 feet; the most severe turbulence is usually encountered at an altitude between 10,000 and 20,000 feet.



NIGHT FLYING

DF-33

INTRODUCTION.

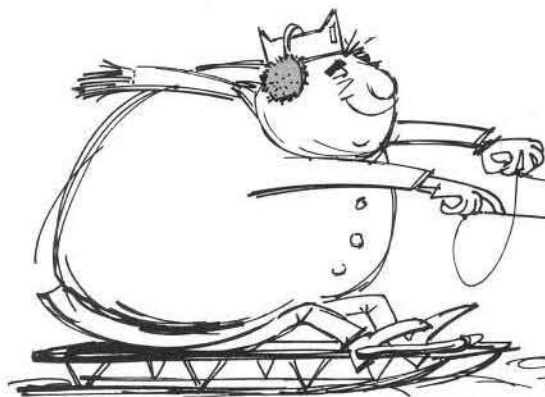
Night flight in this airplane is the same as day flight with the following exceptions.

NIGHT TAKEOFF.

Follow instrument takeoff procedure (with normal reference) until a safe altitude is reached. Prior to landing, visually check main gear down by turning landing lights on in the retracted position.

CAUTION

- Taxi light does not light area near the wing tips. Be on the alert for other airplanes, crew chief stands, and other hazards in the taxi and takeoff areas.
- Check altimeter, vertical velocity indicator, and airspeed indicator, to ensure positive climb and acceleration.



COLD WEATHER PROCEDURES

DF-34

BEFORE ENTERING THE AIRPLANE.

Check to see that the following items have been accomplished:

1. Airplane covers removed.
2. Plugs removed from engine air intake ducts, exhaust nozzles, and engine nacelle doors.
3. Visual check of bottom section of front stator blades for evidence of ice. Engine heat on shutdown will melt ice accumulated on previous flight. Melted ice will then refreeze in the lower section of the front stator and rotor blades. An attempted engine start will result in starter failure. If ice is suspected, check the engine for freedom of rotation. If engine is not free,

external heat must be applied to forward engine section to melt the ice. Start engine as soon as possible after heat application to remove all moisture before refreezing can occur.

4. Wing flap servo followup screw and shaft cleaned of excessive oil and grease.

Note

Excessive oil or grease on this mechanism can cause shaft to bind in screw and move the servo valve spool to partially restrict hydraulic flow to flap motor, causing abnormally slow movement of flaps.

5. All ice removed from fuel tank vents, static air sources, and pitot tubes.

6. Ice and snow removed from nose wheels to prevent shimmy.

7. Fuel filters and draincocks checked for freedom from ice, and heated, if necessary, to drain condensate.

8. Oil tanks preheated, if temperature is -45°C (-49°F) or lower, to reduce starter loads and assure proper lubrication. However, cold engine starts can be made if operations warrant.

9. Shock struts checked for proper inflation, and dirt and ice removed.

CAUTION

Ice should not be chipped away because the airplane may be damaged. Check that water resulting from ice removal does not refreeze on airplane surfaces, especially on control surface hinge lines.

10. All snow and ice accumulations removed prior to flight.

WARNING

Snow and ice that accumulate on the airplane on the ground seriously affect the airplane's flight performance and alter handling characteristics. These accumulations result in longer takeoff distance requirements, increased stall speeds, poor climbout performance, and a vibration in flight that could result in an accident.

11. Canopy jettison system, seat air, and airbrakes serviced before each flight at temperatures below -35°C (-31°F).

BEFORE STARTING ENGINES.

1. Pilot's seat—Adjust as desired.
2. Hydraulic handpump handle—Install in pump. In flight, the radar observer may not be able to reach the handle in its stowed position because of his heavy arctic clothing.
3. In extremely low temperatures, below -40°C (-40°F), apply heat to the back side of the landing gear handle mechanism to clear any ice from the selector valve cable and prevent possible cable slippage.

STARTING ENGINES.

Follow normal starting procedure outlined in Section II. When the engine reaches 10% rpm, open the throttle

halfway and return to IDLE. This additional movement of the throttle loosens any connections that have become stiff, but does not alter the fuel flow. Oil pressure may be high after starting cold engines. This is not dangerous unless the pressure remains high. Delay takeoff until the pressure drops to normal.

CAUTION

When ambient temperature is 0°C (32°F) or below, have hot air from a portable heater blown into the engine air intake ducts and exhaust nozzles for 10 to 15 minutes. This procedure prevents the starter-generator unit from being damaged due to ice seizure of the compressor rotor.

GROUND TESTS.

Because of increased air density at low ambient temperatures, thrust developed at all engine speeds is greater than normal. For ground tests at low temperatures use the following procedures:

1. Generator—Check output and make all checks requiring electrical power before having external power disconnected.
2. Cabin heat, windshield heat, and canopy defog—As required.

CAUTION

To prevent cracking of the windshield glass, keep windshield de-ice and defog knob at NORMAL for at least 1 minute before turning to EMER. Never keep windshield de-ice and defog knob at EMER longer than necessary.

3. Flight controls—Check operation. At temperatures below -35°C (-31°F), operate flight controls three or four times during engine runup until flight controls operate freely and easily.

CAUTION

At very low temperatures, hydraulic packing may fail and cause hydraulic leaks. Have ground personnel check flight control mechanism access doors for signs of excessive leakage.

4. Wing flaps—Check operation.
5. Speed brakes—Check operation and cycle several times to assure free movement.
6. Instruments—Check operation. Flight instruments require approximately 2 minutes for warmup.

WARNING

In cold weather, make sure that all instruments have warmed up sufficiently to ensure normal operation. Check for sluggish instruments during taxiing.

TAXIING INSTRUCTIONS.

When taxiing in cold weather, observe the following precautions:

1. Avoid taxiing in deep snow because taxiing and steering is very difficult, and the brakes may freeze.
2. Taxi very slowly on icy or wet surfaces; the airplane is difficult to control during a skid. On airplanes equipped with steerable nose wheel, steer with nose wheel; on other airplanes use brakes cautiously.

Note

The airplane has a strong tendency to "weather vane" when taxiing on ice. Use the nose wheel steering system to maintain directional control.

CAUTION

- On airplanes not equipped with left hydraulic system supplemental pump use of the wing flaps and speed brakes simultaneously will result in an increase in nose wheel response time, and will necessitate greater than normal rudder pedal throw.
 - On airplanes not equipped with left hydraulic system supplemental pump simultaneous use of wing flaps, speed brakes, and maximum misuse of flight controls will result in complete loss of nose wheel steering.
3. To preserve the battery, use only essential electrical equipment while taxiing at low engine speeds.
 4. When taxiing behind another airplane on icy taxiways, allow enough distance between airplanes for safe stopping and to prevent icing of the airplane surfaces by melted snow and ice in the jet blast of the preceding airplane.

5. When fine powder snow is on the taxiway, the preceding airplane's jet blast will cause a large blinding cloud of flying snow; the distance between airplanes must be increased for visibility.

6. Minimize taxi time to conserve fuel and to reduce amount of fog generated by jet engines.

7. At very low temperatures, operate flight controls frequently.

BEFORE TAKEOFF.

When the taxiway is covered with ice, a full power check may not be possible before takeoff because the airplane may slip on the ice. In this case, the power check can be made at the start of the takeoff run by opening the throttles rapidly and turning on the afterburners. If afterburners do not ignite on both engines, discontinue takeoff. Very low temperatures do not appreciably affect rudder and elevator operation. However, at temperatures below -35°C (-31°F), the ailerons become stiff and should be cycled several times before takeoff to ensure easy movement.

1. Rocket heater switch—ON if mission requires use of rockets.
2. Anti-icing system—ON if necessary.

WARNING

Do not use anti-icing system on takeoff unless runway will allow a 20 to 25 percent longer run than required for normal takeoff. Operation of the anti-icing system causes a reduction in thrust.

3. Fuel filter de-ice switch—Hold at each position for approximately 10 seconds to remove any accumulation of ice.

TAKEOFF.

At the start of the takeoff run, advance the throttles rapidly and turn on afterburners to make power check. If afterburner on either engine does not ignite, do not take off. Exercise extreme caution when steering with brakes during takeoff on an icy runway. After a takeoff from a snow or slush covered field, operate the landing gear, wing flaps, and speed brakes several times to remove slush and snow that might cause these units to freeze in the streamlined positions.

CAUTION

Do not exceed landing gear and flap structural airspeed limitations.

Arctic flight tests have shown that light frost accumulations have no effect on takeoff, and disappear at 250 knots IAS.

DURING FLIGHT.

Flight characteristics are unchanged by arctic conditions except for aileron stiffness at temperatures below -35°C (-31°F). The ailerons should be operated periodically throughout the flight if these temperatures are encountered. If only the left hydraulic system is operating, the rudder should also be operated periodically. Turn on de-icing and anti-icing systems as needed. Check all instruments since some instruments may be unreliable at low temperatures. Prior to penetration, fuel filter should be used for 10 seconds.

Note

Engine fuel control icing will cause the fuel flowmeter indicator to fluctuate (fuel pressure on early aircraft); this indicates that flameout of an engine may be imminent.

APPROACH TO PATTERN.

At temperatures below -35°C (-31°F), operate the ailerons several times before entering the pattern to ensure smooth and easy operation. Follow normal pattern and approach procedures, but allow for longer approach than normal because high thrust at low temperature results in a flatter glide. Wing flap extension requires 2 seconds longer than normal, and retraction requires 7 seconds longer than normal at -65°F . Speed brake operation requires 1.5 seconds additional time to open or close at -65°F . Normal landing gear extension and retraction requires 2 seconds longer at -65°F ; however, emergency extension requires 25 seconds longer.

Note

- When making GCA approaches during arctic operations, decrease power settings about 3 percent because of increased thrust at low temperatures.
- The windshield and canopy defrost systems should be operated at the highest temperature possible (consistent with the pilot's comfort) during high altitude flight in order to provide sufficient preheating of the transparent surfaces to preclude the formation of frost or fog during descent.
- On initial approach use alcohol on each engine for 10 seconds.

LANDING.

CAUTION

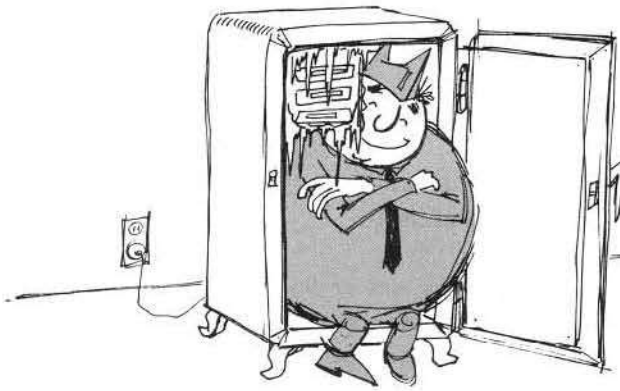
Operation of anti-icing system during landing causes loss of thrust.

When landing on wet or icy runways the minimum landing roll will result with the wing flaps and speed brakes fully extended during the landing roll. The aerodynamic drag of the wing flaps and speed brakes partially offsets the increased braking efficiency experienced when the wing flaps are retracted after landing on a dry runway. Apply brakes carefully and intermittently after touchdown. If the airplane has snow-and-ice tires, apply brakes carefully and intermittently after touchdown to prevent tread from filling and glazing over. Glazing reduces braking effectiveness on icy runways, and landing ground roll distances may be increased as much as 100 percent more than the distances shown in the Landing Distance Chart.

BEFORE LEAVING AIRPLANE.

Check that ground personnel perform the following:

1. Service airplane as soon as possible.
2. Remove dirt and ice from shock struts.
3. Clear snow and ice from nose wheels.
4. Service canopy jettison system and airbrake bottle if temperature is below -35°C (-31°F) and the airplane is to be used for another flight.
5. Check flight control access doors for signs of excessive hydraulic leakage.
6. Install plugs in engine air intake ducts, exhaust nozzles, and engine nacelle doors.
7. Cover pitot tubes and all static air sources.
8. Check fuel pumps, filters, and draincocks for ice and drain condensate within 30 minutes after stopping engines.
9. Bleed and recharge engine screen compressor.
10. Install covers on wings, empennage, and canopy.
11. Remove batteries and store in a heated room if layover of several days is anticipated, or if temperature is below -29°C (-20°F).



HOT WEATHER PROCEDURES

DF-35

INTRODUCTION.

Takeoff and landing rolls are longer in hot weather because of the lower air density. Added precaution should be taken to protect rubber and plastic parts of the airplane from damage by excessive heat.

BEFORE ENTERING THE AIRPLANE.

Check tires for blisters and be sure external ground cooler is disconnected.

TAKEOFF.

Anticipate a longer takeoff distance than normal. Refer to figure A-5 for takeoff distances.

AFTER TAKEOFF.

Be sure to maintain specified climbing airspeed, correcting maximum rates of climb for temperature effects. Refer to Climb Chart, figures A-9 and A-16,

LANDING.

Anticipate longer landing distances and use minimum wheel braking to prevent overheating of brakes. Refer to figure A-24 for landing distance.

BEFORE LEAVING AIRPLANE.

Be sure canopy is protected from direct rays of the sun.



DESERT PROCEDURES

DF-36

INTRODUCTION.

When operating under desert conditions, the normal hot weather procedure is followed. In addition, precautions must be taken to prevent external abrasion of the airplane surfaces and to keep sand and dust from entering the airplane systems. Keeping the canopy closed and canopy seal inflated when the airplane is unoccupied will aid in preventing dust from entering the cockpit.

BEFORE ENTERING THE AIRPLANE.

1. Check exposed shock struts and actuating cylinders for dust and sand. Have them cleaned if necessary.
2. Check all air intakes for sand and dust.
3. Check to see that air, oil, and instrument filters have been cleaned.
4. Check wheel brake disks for excessive abrasion.

BEFORE TAKEOFF.

Do not run engines during a dust or sand storm unless absolutely necessary. Before engine runup, position the airplane so it will not receive dust from, or blow dust on, other airplanes.

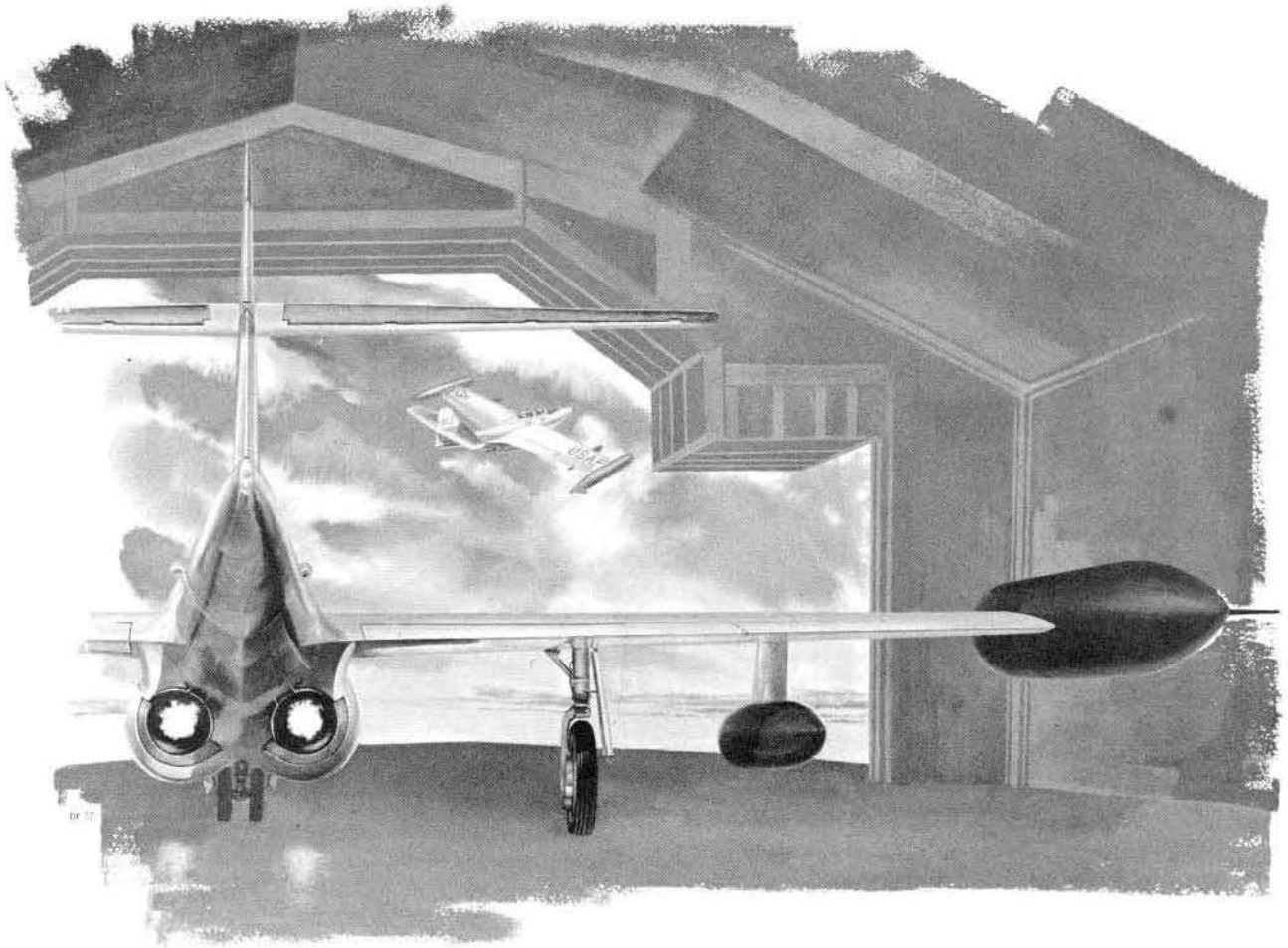
TAKEOFF.

Avoid takeoff in blowing dust or sand.

BEFORE LEAVING AIRPLANE.

Close and seal the canopy during dust or sand storms, and check that ground personnel perform the following:

1. Cover canopy to prevent sand abrasion.
2. Cover all air intakes and ducts as soon as possible after landing.





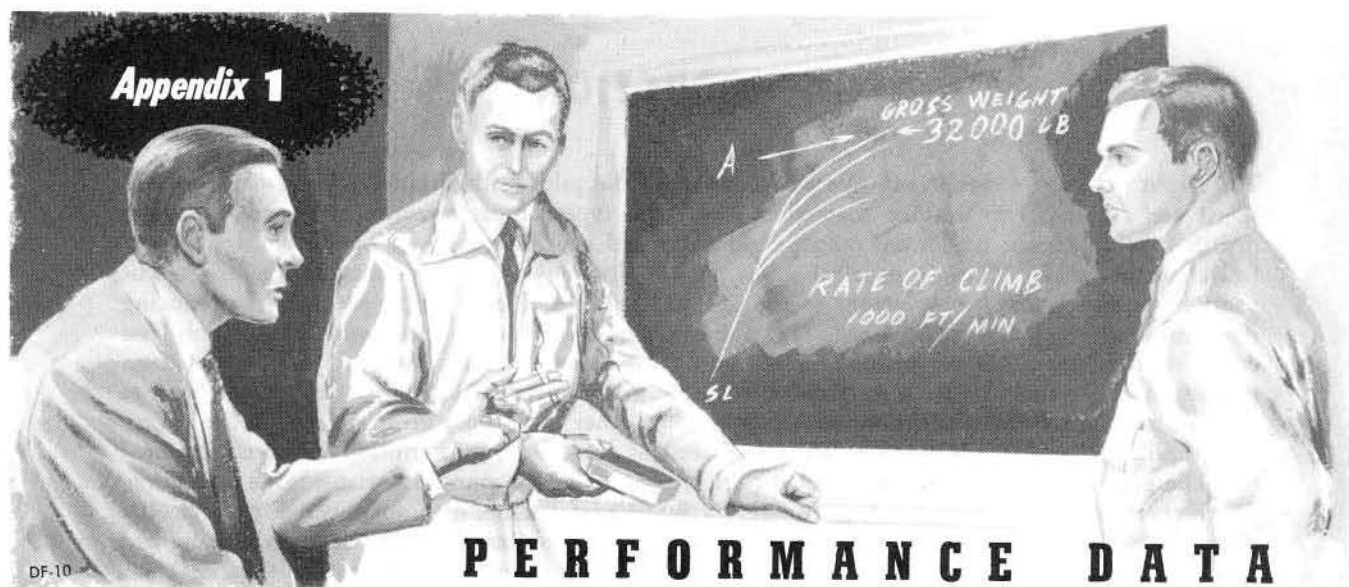


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INTRODUCTION

The flight performance charts in this section provide the pilot with flight planning data and airspeed and ambient temperature correction data. Two types of performance charts are included: profile-type charts for maximum range, endurance, and continuous power operation, and graphical charts for takeoff, climb, nautical miles per 1000 pounds of fuel, descents, and landings. The profile-type charts are a supplement to the graphical data and help flight planning by reducing the computations that must be made. These charts are based on the recommended climb and cruise settings shown on the profile for the particular configuration involved and give direct indication of the fuel and time required to cover a given distance if the recommended settings are adhered to. For flight planning based on settings other than those given on the profile charts, the graphical charts should be used. Decreased weight due to fuel consumption has been accounted for. The graphical charts provide detailed performance data for one- and two-engine operation. These charts should be used for flight planning when performance data not covered in the profile charts is needed. Unless otherwise indicated, all data pertains exactly to NACA standard ambient temperatures but may be considered approximate for nonstandard conditions. The CAS or Mach number tabulated for each pressure altitude should be maintained for nonstandard temperatures regardless of the deviations of other quantities from the given values, except when it is necessary to use a lower CAS value or Mach number to avoid exceeding engine limits.

CORRECTION TABLES.

AIRSPED CORRECTIONS.

Assuming zero instrument error, the pilot's airspeed indicator reads correct indicated airspeed (IAS). Corrections must be applied to IAS to determine calibrated airspeed (CAS), equivalent airspeed (EAS), and true airspeed (TAS). The algebraic sum of the installation correction and IAS equals CAS. The CAS value minus the compressibility correction equals EAS. EAS divided by the square root of the relative air density ($\sqrt{\sigma}$) equals TAS. Relative air density is equal to the ratio of the free airstream ambient density at altitude to standard sea level density. Wind velocity added vectorially to TAS equals ground speed (GS). Corrections to be applied to convert IAS to CAS are shown in the Airspeed Position Correction Table (figure A-1). These corrections are given for values of IAS and pressure altitude for the operating range of the clean configuration; corrections for flap settings and gross weights are also shown. Landing gear position has no effect on airspeed readings. Values for converting CAS to EAS are shown in the Compressibility Correction to Calibrated Airspeed Table (figure A-2) which covers the operating CAS and pressure altitude range of the airplane. Values of the reciprocal of the square root of the relative air density ($1 \div \sqrt{\sigma}$), used for determining TAS, are obtained from the Density Altitude Table (figure A-4). The airspeed indicator in the radar observer's cockpit indicates approximate TAS; therefore, only the wind correction need be applied to determine ground speed.

AMBIENT TEMPERATURE CORRECTION.

A compressibility correction must be applied to the temperature gage reading to obtain true ambient temperature. This correction is shown as a function of CAS and pressure altitude in the Temperature Correction for Compressibility Table (figure A-3).

EXAMPLE OF THE USE OF THE CORRECTION TABLES.

Assume the following instrument readings:

- | | |
|------------------------------|-----------|
| 1. Altimeter | 35,000 ft |
| 2. Airspeed indicator | 284 kn |
| 3. Free air temperature gage | -19°C |

The correct airplane speed and ambient temperature are:

- | | |
|--|--------|
| 4. IAS (zero instrument error) | 284 kn |
| 5. Installation correction | + 6 kn |
| 6. CAS | 290 kn |
| 7. Compressibility correction | -18 kn |
| 8. EAS | 272 kn |
| 9. Free air temperature gage reading | -19°C |
| 10. Temperature correction for compressibility error | + 25°C |
| 11. Correct ambient temperature | -44°C |

At 35,000-foot pressure altitude and -44°C, the reciprocal of the square root of the relative air density ($1 \div \sqrt{\sigma}$) from figure A-4 is 1.85. Therefore, TAS is $272 \times 1.85 = 503$ knots.

PERFORMANCE CHARTS.

TAKEOFF DISTANCE CHARTS.

The Takeoff Distance Charts (figure A-5) show takeoff distances (ground roll and total distance to clear a 50-foot obstacle) as a function of gross weight, pressure altitude, wind velocity, and ambient temperature for a dry, hard-surfaced runway. Gross weight, wind velocity, and ambient temperature are always known factors; the pressure altitude of the field can be determined by setting the altimeter to 29.92 (sea level standard day pressure in inches of mercury). The charts show data for two-engine takeoffs with maximum or military power, using the normal procedure given in Section II. If an engine fails during military power takeoff, afterburning on the operating engine should be started immediately or the takeoff discontinued. Military power data may be used to estimate adequate field length if afterburners fail during takeoff.

Note

Takeoff with military power will result in a fuel saving of only 250 pounds. This fuel saving will result in an increased range of only 25 nautical miles. The slight increase in range must be weighed against the additional risks involved in military power takeoffs.

Single-engine maximum power takeoff data is also included to determine the required takeoff distance when power on one engine is lost during takeoff (see Section III). If the takeoff technique used is different from that specified in Section II, the distances will differ from those shown in the charts. A deviation of 5 percent from the airspeeds in Section II will result in a distance deviation of 10 percent or more.

Use of Takeoff Distance Charts.

Example 1 shows a maximum power takeoff at an ambient air temperature of 15°C, pressure altitude of 2000 feet, gross weight of 40,000 pounds, and a 20-knot headwind. This results in a ground roll of 2700 feet and a total distance of 3600 feet to clear a 50-foot obstacle.

CRITICAL FIELD LENGTH CHART.

The Critical Field Length Chart (figure A-6), in conjunction with the Maximum Refusal Speed Chart (figure A-7), can be used to determine a course of action if an engine fails at any point during the takeoff ground run for any combination of critical field and runway lengths. For example, comparison of the critical field length with the runway length available indicates the following takeoff limitations:

Runway Length Greater Than Critical Field Length.

1. At engine failure speeds below maximum refusal speed: If the runway is longer than necessary for one-engine takeoff, the pilot has the option of either taking

off or stopping. If the runway is shorter than necessary for one-engine takeoff, pilot must stop.

2. At engine failure speeds above maximum refusal speed, pilot must take off, as stopping within the limits of the runway is impossible.

Critical Field Length Greater Than Runway Length.

1. At engine failure speeds below maximum refusal speed, pilot must stop, as takeoff within the limits of the runway is impossible.

2. At engine failure speeds above maximum refusal speed, takeoff and stopping within the limits of the runway are both impossible.

Use of Critical Field Length Charts.

Example 2 shows a maximum power takeoff with an ambient air temperature of 15°C, a pressure altitude of 2000 feet, a gross weight of 40,000 pounds, and a 20-knot headwind. These conditions indicate a critical field length of 4700 feet. According to the Takeoff Distance Chart (A-5) for one-engine takeoff, the runway length required for one-engine takeoff is 7500 feet. If the available runway length is 7000 feet, the maximum refusal speed is found to be 115 knots IAS. Thus, the available runway length is greater than the critical field length but shorter than necessary for one-engine takeoff. Under these conditions, if the speed at the point of engine failure is less than 115 knots IAS, the pilot should stop the airplane rather than attempt a one-engine takeoff; if the speed at the point of engine failure is greater than 115 knots IAS, the pilot should take off, as stopping within the limits of the runway would not be possible.

MAXIMUM REFUSAL SPEED CHART.

The Maximum Refusal Speed Chart (figure A-7) shows the maximum speed at which engine failure permits stopping at the end of the runway. It is based on normal takeoff procedure and a dry hard-surfaced runway.

Use of Maximum Refusal Speed Chart.

Example 3 shows a maximum power takeoff at a gross weight of 40,000 pounds and a pressure altitude of 2000 feet with an ambient air temperature of 59°F and a 7000-foot runway. The resulting maximum refusal speed is 115 knots.

VELOCITY DURING TAKEOFF GROUND RUN CHARTS.

The Velocity During Takeoff Ground Run Charts (figure A-8) are based on normal operating procedures as specified in Section II and show the relationship between indicated airspeed and distance traveled during takeoff ground run on a dry hard-surfaced runway. These charts are useful for checking takeoff acceleration by reference to a check point located a known distance along the runway from the start of the takeoff ground run.

TAKEOFF DISTANCE

MODEL: F-89D

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS

J35-35

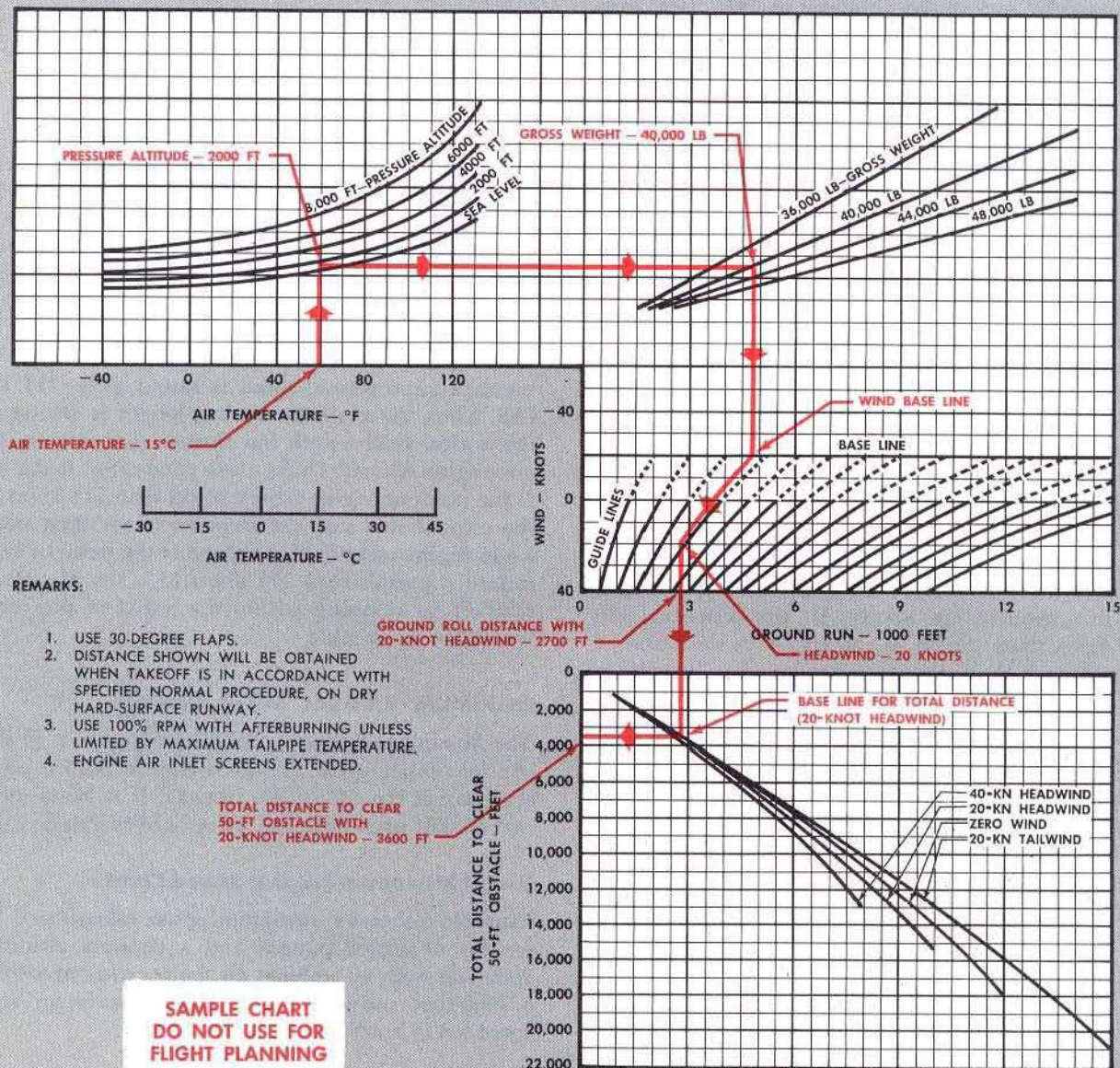
OR

J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

ENGINE(S): (2)

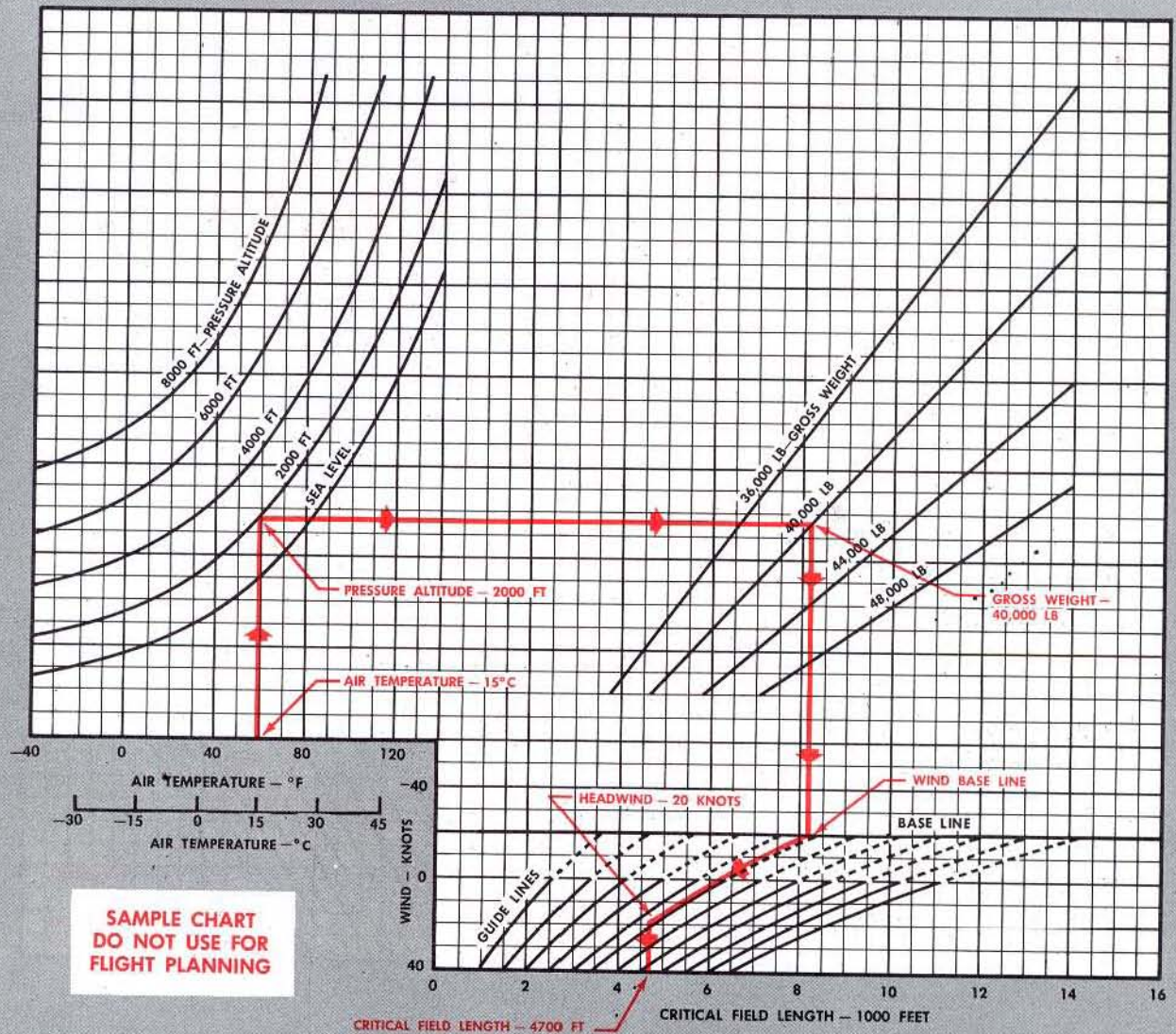
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

GROSS WEIGHT	IAS — KNOTS		
	NOSE WHEEL OFF	TAKEOFF	50-FT OBSTACLE
36,000 LB	117	122	133
40,000 LB	124	129	141
44,000 LB	130	135	147
46,638 LB	134	139	151

Example 1.

CRITICAL FIELD LENGTH

MODEL: F-89D

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56MAXIMUM POWER
WITH OR WITHOUT PYLON TANKSJ35-35
OR
ENGINE(S): (2) J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

REMARKS:

1. ALL VALUES SHOWN ON CHART ARE BASED ON DRY HARD-SURFACE RUNWAY, 30-DEGREE FLAPS, AND SPEED BRAKES INOPERATIVE.
2. THREE SECONDS ALLOWED FOR PILOT RECOGNITION OF ENGINE FAILURE, AT THE END OF THE THREE SECONDS, THROTTLES ARE CUT AND BRAKES APPLIED.
3. ENGINE INLET SCREENS EXTENDED.

MAXIMUM REFUSAL SPEEDS

MODEL: F-89D

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS

J35-35

OR

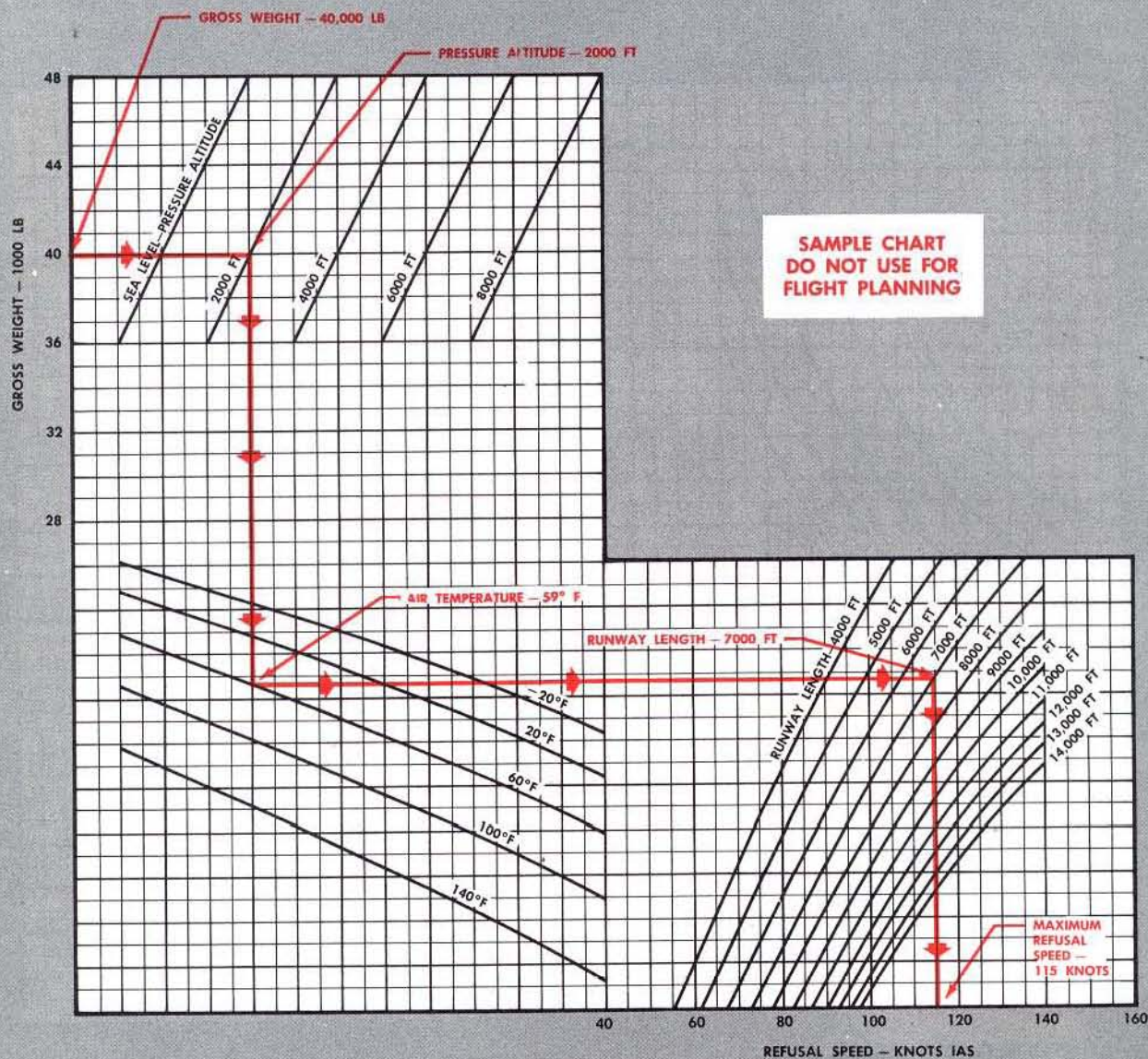
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



**SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING**

REMARKS:

1. ABOVE VALUES ARE BASED ON DRY HARD-SURFACE RUNWAY, USING SPECIFIED NORMAL TAKEOFF PROCEDURE UP TO POINT OF ENGINE FAILURE AND OPERATION IN ACCORDANCE WITH SECTION III AFTER ENGINE FAILURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

D-302

Example 3.

Use of Velocity During Takeoff Ground Run Charts.

Enter the chart at the applicable gross weight of the airplane. Read over to the base line, then proceed vertically downward to the required takeoff ground run distance as determined from the Takeoff Distance Charts (figure A-5). From this point, trace a curve parallel to the guide lines until it intersects the distance being used as a check point. This point shows the velocity which should be attained at that distance. In the example shown (example 4), the takeoff gross weight is 40,000 pounds, the required takeoff distance at maximum power is 2700 feet, and the distance from the start of the takeoff run to the acceleration check point is 1500 feet. The resulting velocity at the check point is 96 knots IAS, and the takeoff velocity is 128 knots IAS.

BEST CLIMB CHARTS.

The Best Climb Charts (figures A-9 and A-16) show climb performance in terms of fuel, time, air distance, rate of climb, and climb CAS necessary to attain this performance. Data is given for climbing with two engines at maximum, military, and normal power, and for one engine with maximum power. The fuel, time, and air distance values shown include the effects of kinetic energy change and weight reduction during climb, but do not include any allowance for start, takeoff, or acceleration. Time and distance are plotted against gross weight with guide lines to show the reduction in gross weight during climb due to fuel consumption. Three charts are provided for each configuration and power setting; these include two Best Climb Performance Charts (one plotted against distance, the other plotted against time) and one Best Climb Speed Chart (showing rate of climb and best climb CAS).

Use of Best Climb Charts.

To obtain the desired data from the Best Climb Performance Charts, enter the proper climb chart at the gross weight and altitude at start of climb and note the time (or distance) and fuel used at this point. From this initial point, trace a curve parallel to the guide lines until it intersects the desired altitude at end of climb. Note the time (or distance) and fuel used at this intersection. The difference between the initial and final time is the time required to climb. The difference between the initial and final values for distance and for fuel used gives, respectively, the distance traveled and fuel used in climb. Since time, distance, and fuel used in climb are zero at sea level, these values may be read directly for climbs starting at sea level. It must be kept in mind, however, that for a climb following takeoff, the initial climb weight is the takeoff gross weight minus the 906-pound takeoff fuel allowance. Example 5 shows the fuel used and time to climb from 10,000 feet to 35,000 feet using military power with pylon tanks and a gross weight of 41,000 pounds

at start of climb. Rate of climb and best climb CAS may be obtained directly from the Best Climb Speed Charts.

NAUTICAL MILES PER 1000 POUNDS FUEL CHARTS.

Cruise data throughout the normal speed range may be obtained from the Nautical Miles Per 1000 Pounds Fuel Charts (figures A-10 and A-17). Each chart includes specific range (nautical miles per 1000 pounds), fuel flow (pounds per hour), and power settings (% rpm), as well as curves of maximum endurance and recommended long range cruise speeds for zero wind and 50-knot headwind. Specific range is plotted against Mach number, with subscales of calibrated airspeed (CAS) and true airspeed (TAS).

Use of Nautical Miles Per 1000 Pounds Fuel Charts.

To obtain the cruising range for a given amount of fuel, use the following steps:

1. Select the proper chart for the airplane configuration and altitude.
2. Determine the average weight of the airplane for the amount of fuel being considered.
3. Enter the graph at this average weight and the desired Mach number, or desired power setting (% rpm), to obtain specific range (nautical miles per 1000 pounds of fuel).
4. Multiply the specific range by the amount of fuel (pounds $\div$ 1000) to obtain cruising range.
5. Interpolate the approximate fuel flow and power setting (% rpm) at the Mach number and average weight.

MISSION PROFILE CHARTS.

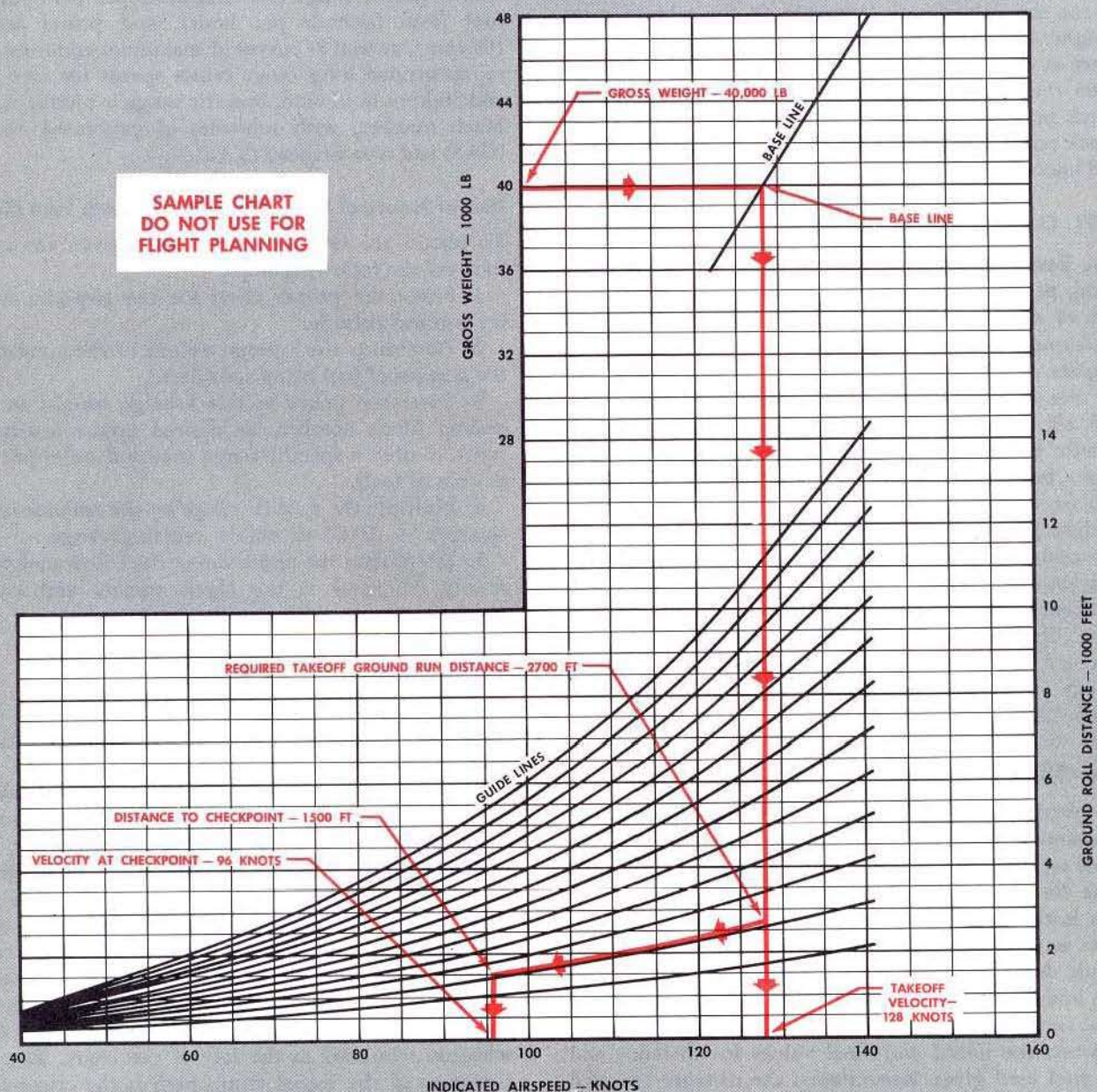
The Mission Profile Charts (figures A-11 and A-18) show the relationship of time, fuel, distance, and altitude to maximum range for no-wind conditions. This relationship is based on a mission sequence of takeoff, military power climb, and long range cruise. The fuel curves include a 906-pound allowance for start, taxi, and takeoff; the fuel used in climbing to each altitude, and the fuel required for long range cruise. The time lines include the time required for climbing to cruise altitude, but do not include the time for start, taxi, or takeoff. The line labeled Initial Climb Path shows the distance traveled during the military power climb from sea level to cruising altitude, using the climb speed schedule tabulated at the left of the chart. The continuation of the initial climb path is the cruise-climb path based on a constant Mach number. The approximate best cruise-climb altitude can be obtained by climbing at the recommended military power schedule until the rate of climb is 500 feet per minute, then leveling off and setting up the recommended power setting and Mach number. The airplane will automatically seek the cruise-climb altitude for its particular gross weight. The initial throttle setting should be maintained throughout the remainder of cruise-climb.

VELOCITY DURING TAKEOFF GROUND RUN

MODEL: F-89D

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKSJ35-35
OR
J35-47DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56

MILITARY POWER

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GALSAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING

REMARKS:

1. VELOCITIES SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

D-303

Example 4.

BEST CLIMB PERFORMANCE

MODEL: F-89D

MILITARY POWER
WITH PYLON TANKS

J35-35

OR

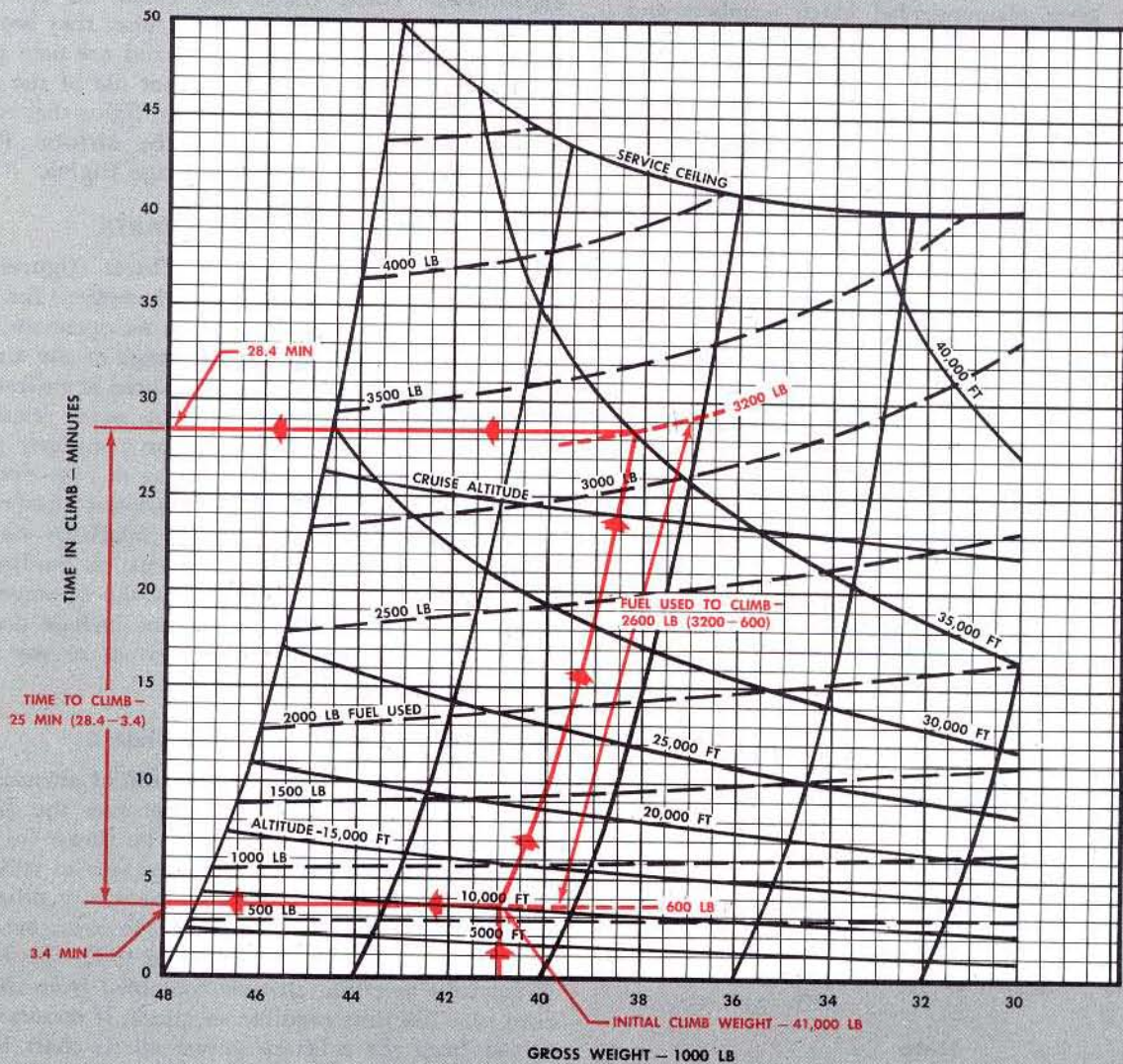
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

**SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING**

D-304

Example 5.

For cruise at a constant altitude, the recommended Mach number should be set up at the intersection of the climb path and the cruise altitude. As the flight progresses, the power setting must be decreased gradually to maintain the recommended Mach number as fuel is consumed. As an aid to preflight planning, a line of best range for constant-altitude flight appears on the chart. This curve is not a flight path, but a plot of best cruise altitude against distance. For distances greater than those covered by the curve, cruise-climb procedure for maximum range should be used. A cruise table gives recommended Mach numbers and approximate operating conditions for both cruise-climb procedure and cruise at constant altitude.

Use of Mission Profile Charts.

The charts may be entered with one or more of the four range factors of time, fuel, distance, and altitude. By entering the chart with the known factors, the others may readily be determined for a no-wind condition. To determine wind effect upon time, fuel, and distance, compute the average true airspeed (distance $\div$ time, no wind) and apply wind to TAS to obtain ground speed (GS). Then compute the time with wind (distance $\div$ GS). Reenter the profile at the cruising altitude and the computed time with wind to determine the fuel required with wind.

Sample problem 1. Using example 6, find the fuel required, time, necessary speed, and power setting to cruise 250 N Mi at 20,000 ft. against a headwind of 40 kn with no external load.

1. Enter at 250 N Mi and 20,000 ft
to obtain fuel required (no wind) 4800 lb
2. Time (no wind) 40 min (0.67 hr)
3. Calculated average TAS (250 $\div$ 0.67) 375 kn
4. Apply wind to obtain GS (375 - 40) 335 kn
5. Calculate time with 40-kn wind
(250 $\div$ 335) 45 min (0.75 hr)
6. Reenter at cruise altitude at the
time with wind. Fuel required with wind 5200 lb
7. Tabular cruise speed 0.62 Mach No.
8. Tabular cruise power
setting 86% rpm (approx)

Note

If this flight had been made at 28,500 ft cruising altitude (reference, the line of best range at 250 N Mi), the time and fuel required would have been less.

Sample problem 2. Determine the maximum distance flyable with no external load and with 10,000 lb of fuel and a 60-kn headwind.

1. Enter at 10,000 lb of fuel and obtain
maximum air distance at cruise-climb
(no wind) 860 n mi
2. Time (no wind) 2 hr 7 min (2.12 hr)

3. Calculate average TAS (860 $\div$ 2.12) 406 kn
4. Apply wind to obtain GS (406 - 60) 346 kn
5. Calculate distance with wind
(2.12 $\times$ 346) 733 n mi
6. Tabular cruise-climb speed: 0.71 Mach No.

INTERCEPT PROFILE CHARTS.

The Intercept Profile Charts (figures A-12 and A-19) present the fuel required to fly a given distance in a minimum of time, consistent with reasonable range capabilities. These charts are based on maximum power climb and military power cruise; they are similar to the Mission Profile Charts and are used in the same manner. Notice, however, that use of the Intercept Profiles should be restricted to flights that require a minimum of time, whereas the Mission Profile Charts are used for maximum range flights.

OPTIMUM RETURN PROFILE CHARTS.

The Optimum Return Profile Charts (figures A-13 and A-20) show the minimum fuel required for maximum distance (no wind) based on an optimum flight path from any point within the range of the airplane configuration. The flight path required is indicated by the different shaded areas and the notes relative to them. The fuel curves are based on a military power climb to, and recommended cruise at, the optimum altitude. The military power climb speed schedule and recommended cruise settings are tabulated on each chart. No reserve for loiter, descent, or landing has been included. The time shown at the optimum altitude is cruise time only; it does not include the time required for climb to optimum altitude or any allowance for loiter, descent, or landing.

Use of Optimum Return Profile Charts.

The chart may be entered at the initial altitude with either the fuel on board (to determine the distance available) or with the distance to be flown (to determine the fuel required). The shaded area in which the initial point falls establishes the necessary procedure, as stated in the note relative to the area, to obtain maximum range. The time required to fly the distance is the time at cruise altitude (obtained from the profile) plus the time required to climb, if necessary (obtained from the military power climb chart for the applicable configuration). The effect of wind must be applied to obtain the actual fuel and time to fly the distance. A close approximation can be obtained by considering the head or tailwind for the time it requires to complete the flight (neglecting the difference in wind at the lower altitudes since comparatively little time is spent during the climb phase).

Sample problem. From example 7 determine the fuel and time required to return to a base 800 N Mi away. The airplane, carrying pylon tanks, is at 20,000 ft with 9500 lb of fuel on board (gross weight = 40,720 lb). A 60-kn headwind is assumed.

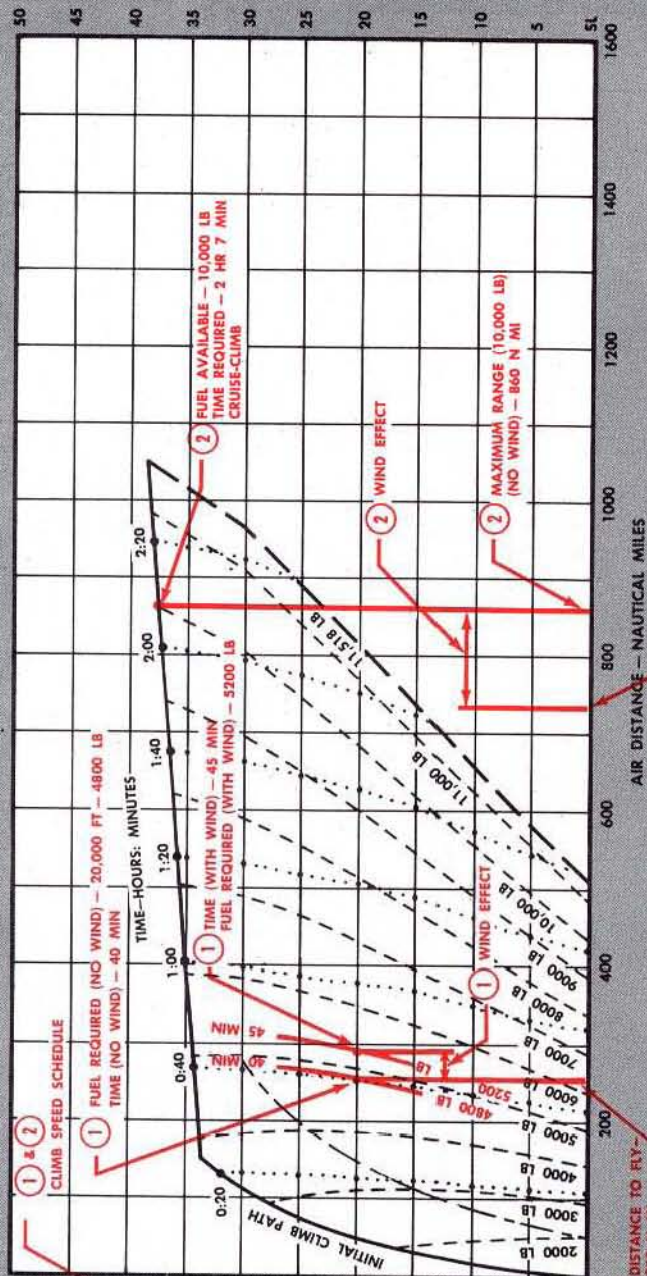
MISSION PROFILE

TAKEOFF GROSS WEIGHT
42,455 POUNDS
LONG RANGE CRUISE

MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: NO EXTERNAL LOAD

MILITARY POWER CLIMB		ALT 1000 FT
MACH NO.	CAS	
.70	230	45
.71	270	40
.69	290	35
.65	300	30
.60	310	25
.56	310	20
.53	320	15
.50	330	10
		5
		SL



REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF—906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MILITARY POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

**SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING**

LEGEND

— ZERO FUEL REMAINING

--- FUEL CONSUMED

— CRUISE-CLIMB PATH

..... TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)

--- LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

CRUISE—NO EXTERNAL LOAD			
ALTITUDE FEET	MACH NO.	CAS	APPROXIMATE LB/HR % RPM
CRUISE-CLIMB	.71	410	3700-3400 *
30,000	.68	255	400 3900 88
25,000	.65	270	390 4200 87
20,000	.62	285	380 4600 86
15,000	.58	295	365 5000 84
10,000	.54	300	345 5400 83
5,000	.51	305	330 6000 82
SEA LEVEL	.48	315	315 6600 80

CRUISE-CLIMB PROCEDURE		
ALTITUDE FEET	% RPM	MACH NO.
34,000	94	.71
35,000	93	.71
36,000	93	.71
37,000	92	.71
38,000	92	.71

Example 6.

OPTIMUM RETURN PROFILE

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56

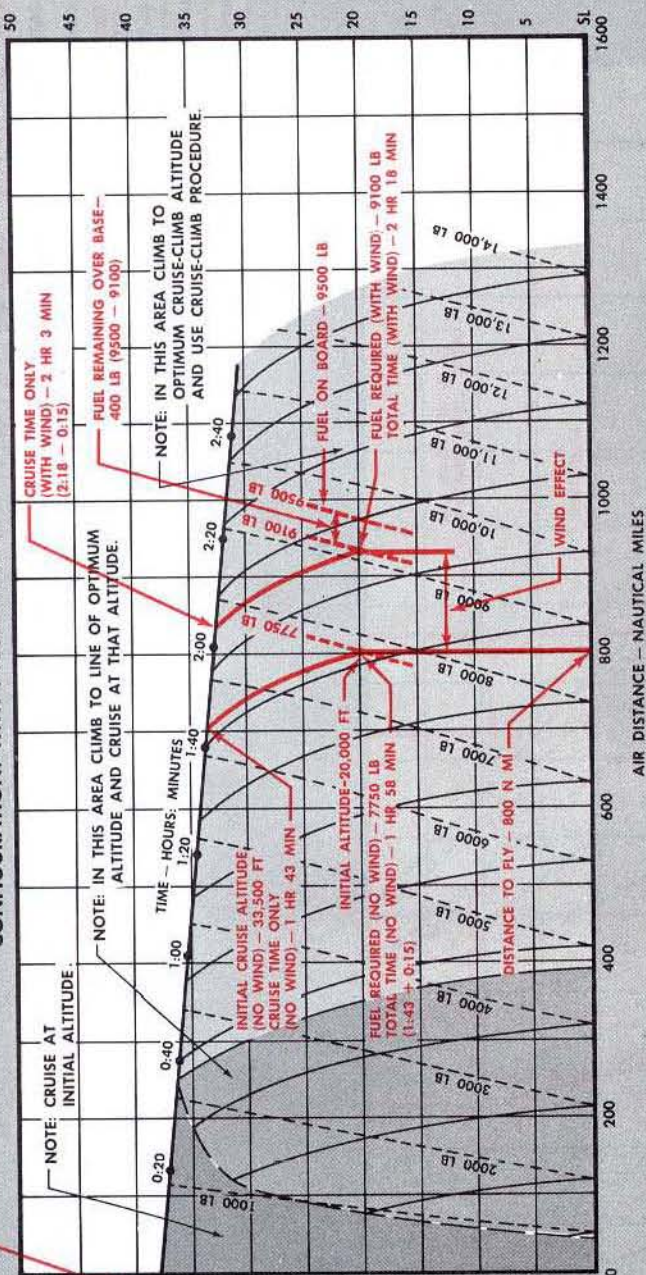
TAKEOFF GROSS WEIGHT
46,638 POUNDS

CLIMB SCHEDULE
TIME TO CLIMB - 15 MIN
(MILITARY POWER
CLIMB CHART)

MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

MILITARY POWER CLIMB		ALT 1000 FT
MACH NO.	CAS	
.70	230	45
.69	260	40
.67	280	35
.63	290	30
.59	300	25
.55	300	20
.51	310	15
.48	320	10
		5
		SL

CONFIGURATION: WITH PYLON TANKS



REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO FLIGHT ALTITUDE (IF BELOW THAT).
2. NO ALLOWANCE MADE FOR LOITER, DESCENT, OR LANDING.
3. BEST CRUISE CONDITION DETERMINED BY INTERSECTION OF CLIMB PATH GUIDE LINES AND LINES OF BEST RANGE.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING

LEGEND

● TIME AT CRUISE-CLIMB ALTITUDE

--- FUEL REQUIRED

--- CLIMB PATH GUIDE LINE

--- LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

--- LINE OF BEST RANGE FOR CRUISE-CLIMB FLIGHT

CRUISE - WITH PYLON TANKS				
ALTITUDE FEET	MACH NO.	APPROXIMATE		
		CAS	TAS	LB/HR % RPM
CRUISE - CLIMB	.70		405	4500 - 3500 *
30,000	.68	255	400	4100 90
25,000	.65	270	390	4400 88
20,000	.62	285	380	4800 87
15,000	.58	290	360	5200 85
10,000	.54	295	340	5600 83
5,000	.50	305	325	6200 82
SEA LEVEL	.48	315	315	6800 81

CRUISE-CLIMB PROCEDURE		
ALTITUDE FEET	% RPM	MACH NO.
31,000	94	.70
32,000	94	.70
33,000	94	.70
34,000	93	.70
35,000	93	.70
36,000	93	.70
37,000	92	.70

CRUISE-CLIMB PROCEDURE

Example 7.

1. Enter profile at 800 N Mi and 20,000 ft to establish starting point. Fuel required (no wind) 7750 lb
2. In this area, note that a climb is required and a cruise-climb procedure followed.
3. By following the climb path guide lines, the initial cruise altitude is 33,500 ft.
4. Cruise time (no wind) 1 hr 43 min
5. From the military power climb chart for pylon tank configuration, time to climb 15 min
6. Total time (no wind; "4" + "5") 1 hr 58 min
7. Average TAS (distance ÷ total time) 407 kn
8. Average ground speed (TAS -- headwind) 347 kn
9. Total time with headwind (distance ÷ average ground speed) 2 hr 18 min
10. Cruise time with wind ("9" -- "5") 2 hr 3 min
11. Using the cruise time "10" on the profile, backtrack down the climb path from the line of best range to 20,000 ft to obtain fuel required with wind 9100 lb
12. Fuel remaining over base at altitude (9500 lb -- 9100 lb) 400 lb
13. Use the flight path originally determined at no wind.

MAXIMUM ENDURANCE CHARTS.

The Maximum Endurance Charts (figures A-14 and A-21) show the maximum time available with the fuel on board when loitering at a constant altitude. The recommended calibrated airspeed and the approximate operating conditions are tabulated on each chart.

Use of Maximum Endurance Charts.

To determine the time available for a given amount of fuel, enter the chart at the amount of fuel on board at the start of loiter and the flight altitude and note the initial time. Reenter the chart at the amount of fuel on board at the end of the endurance flight (initial fuel on board less fuel to be used) and read the final time. The difference between the initial and final time is the time available to loiter at constant altitude. To obtain the fuel required to loiter a given time, enter the chart at the amount of fuel on board at the start of loiter and flight altitude and note the initial time. Reenter the chart at time of end of loiter (initial time less time to loiter) and read final fuel on board. The difference between the initial and final fuel on board is the fuel required to loiter.

Sample problem. From example 8 determine the fuel required to loiter at 30,000 ft with no external load for 45 min. The fuel on board at start of loiter is 6000 lb (gross weight = 36,937 lb).

1. Initial time at 6000 lb and 30,000 ft 1 hr 58 min
2. Final time (1:59 -- 45) 1 hr 13 min
3. Fuel on board at end of loiter (1:13 at 30,000 ft) 3550 lb
4. Fuel required to loiter (6000 lb -- 3550 lb) 2450 lb
5. Recommended loiter CAS 190 kn

OPTIMUM MAXIMUM ENDURANCE PROFILE CHARTS.

The Optimum Maximum Endurance Profile Charts (figures A-15 and A-22) give the maximum time in the air with the fuel remaining, based on an optimum flight path from any starting altitude. The flight path required is indicated by the different shaded areas and the notes relative to them. Time and fuel lines shown are based on a normal power climb (military power climb in the case of one-engine operation) to best endurance altitude, loiter at that altitude, and a maximum range descent to sea level (no reserve for landing). The climb speed schedule is tabulated at the left of the chart; the loiter speed schedule is tabulated below the chart.

Use of Optimum Maximum Endurance Profile Charts.

The chart may be entered at the initial altitude with either the fuel remaining (to determine the time available) or the time desired (to determine the fuel requirement). The shaded area in which the initial point falls establishes the flight path to be used, as stated in the note relative to the area.

Sample problem. From example 9 determine the time available and the necessary flight path for maximum endurance aloft in the pylon tank configuration with 6000 lb of fuel remaining at 25,000 ft.

1. Enter profile at 25,000 ft and 6000 lb of fuel remaining to establish starting point. Total time available 1 hr 59 min
2. In this area, note that a climb is required.
3. Follow the climb path guide lines for the best endurance altitude 33,500 ft
4. Descent time from 33,500 ft to sea level 27 min
5. Elapsed time from start of climb to start of descent 1 hr 32 min (1:59 -- 0:27)

Suppose a reserve of 1000 lb of fuel had been desired for landing; then enter the profile at 5000 lb fuel (6000 -- 1000) and proceed as outlined in "1" through "5".

6. Time available 1 hr 42 min
7. Attain endurance altitude 33,000 ft
8. Descent time 26 min
9. Elapsed time 1 hr 16 min

MAXIMUM ENDURANCE

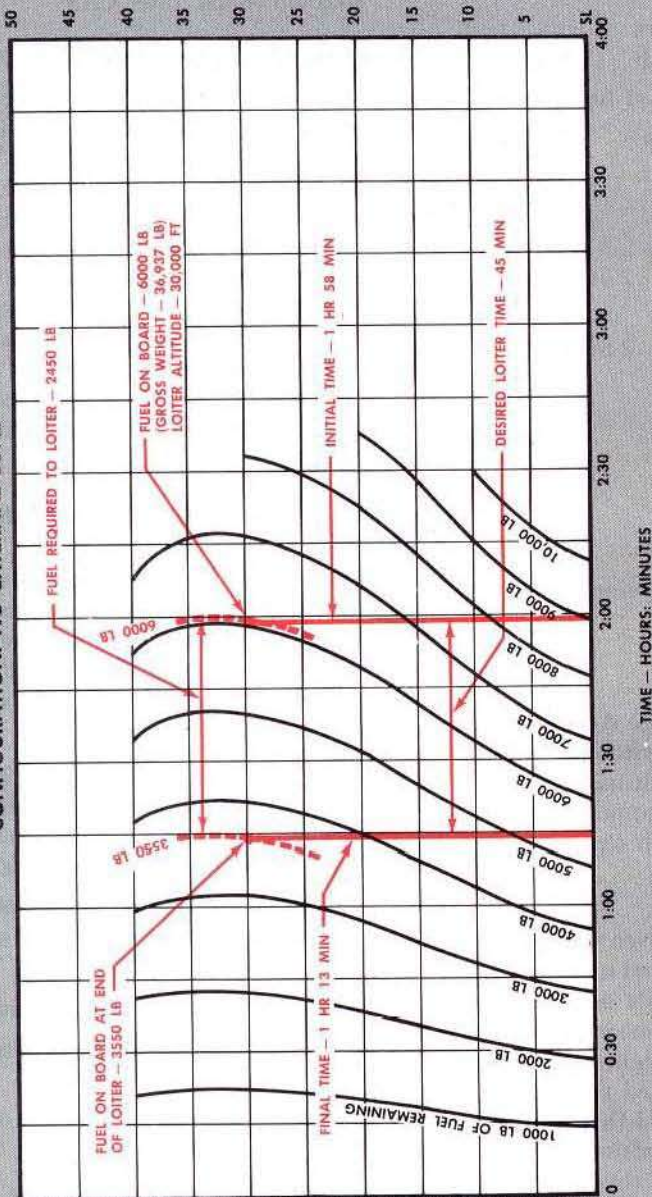
TAKEOFF GROSS WEIGHT

42,455 POUNDS

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: NO EXTERNAL LOAD

ALTITUDE FEET
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
SEA LEVEL



REMARKS:

1. LOITER AT RECOMMENDED CAS.
2. MAINTAIN CONSTANT ALTITUDE.
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.

SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING

ALTITUDE FEET	CAS	LOITER		
		TAS	MACH NO.	APPROXIMATE LB/HR % RPM
40,000	200	380	.66	3300 99
35,000	195	340	.59	3100 88
30,000	190	300	.52	3200 85
25,000	195	285	.47	3300 82
20,000	195	260	.43	3500 79
15,000	195	240	.39	3700 77
10,000	195	225	.35	4000 74
5,000	195	205	.32	4300 71
SEA LEVEL	195	195	.29	4600 69

RECOMMENDED
LOITER CONDITIONS

Example 8.

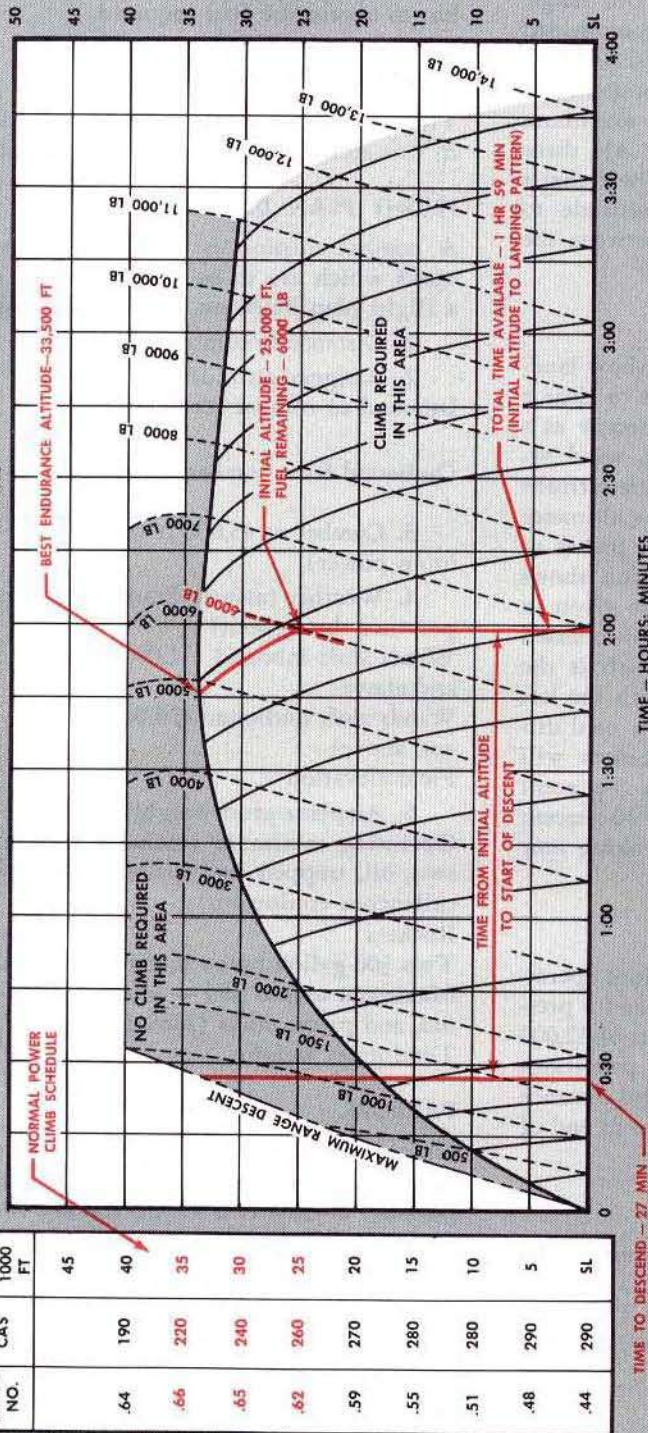
OPTIMUM MAXIMUM ENDURANCE PROFILE

TAKEOFF GROSS WEIGHT
46,638 POUNDS

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56

MODEL: F-89D
ENGINE(S): (2) J35-35 or J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: WITH PYLON TANKS



TIME - HOURS: MINUTES

TIME TO DESCEND - 27 MIN

REMARKS:

1. USE NORMAL POWER FOR CLIMB.
2. LOITER AT RECOMMENDED CAS.
3. USE MAXIMUM RANGE DESCENT.
4. NO ALLOWANCE OR RESERVE MADE FOR LANDING.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- FUEL REMAINING
- LINE OF OPTIMUM ALTITUDE FOR LOITER
- NORMAL POWER CLIMB GUIDE LINES.

LOITER — WITH PYLON TANKS					
ALTITUDE FEET	CAS	APPROXIMATE			
		MACH NO.	TAS	LB/HR	% RPM
40,000	190	.65	370	3500	100
35,000	195	.59	340	3400	91
30,000	195	.52	310	3300	86
25,000	195	.47	280	3400	83
20,000	195	.43	260	3700	81
15,000	195	.39	240	3900	78
10,000	195	.35	225	4200	75
5,000	195	.32	210	4500	73
SEA LEVEL	195	.30	195	4800	70

SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING

RECOMMENDED LOITER

Example 9.

DESCENT CHARTS.

The Descent Charts (figure A-23) show descent performance for one and two engines operating in terms of fuel, time, air distance, and rate of descent for a gross weight range from 32,000 to 44,000 pounds, denoted by the shaded areas. Interpolation must be used for intermediate gross weights within this range. Three types of descents are shown: recommended descent with speed brakes closed (based on 0.70 Mach number), recommended descent with speed brakes open (also based on 0.70 Mach number), and maximum range descent (based on 208 knots IAS). All three types of descent are based on idle power. These charts may be used for descending from one altitude to another by taking the incremental values between the initial and final altitudes.

LANDING DISTANCE CHARTS.

The Landing Distance Charts (figure A-24) show landing distances (ground roll and total distance to clear a 50-foot obstacle) for a dry hard-surfaced runway as a function of gross weight, pressure altitude, wind velocity, and ambient temperature. The pressure altitude of the field can be determined by setting the altimeter to 29.92 (sea level standard day pressure in inches of mercury). The chart for two-engine operation shows data for landing using the normal procedure given in Section II. The chart for one-engine operation is based on inoperative speed brakes and flaps, which is the landing configuration for some airplanes with the left engine inoperative. If the landing technique used differs from that specified, the landing distances will vary from those shown on the charts. A 5-percent variation in speed causes approximately a 10-percent variation in distances; insufficient wheel braking may increase ground roll by 50 percent.

Use of Landing Distance Charts.

Example 10 shows a landing with two engines operating at an ambient air temperature of 15°C and a pressure altitude of 2000 feet with a gross weight of 32,000 pounds and a 20-knot headwind. These conditions require a ground roll of 2550 feet and a total distance of 3600 feet from a 50-foot obstacle clearance to end of ground roll.

LANDING SPEEDS CHART.

The Landing Speeds Chart (figure A-25) presents the recommended indicated airspeeds for final approach, 50-foot obstacle clearance, and touchdown. The chart may be read for applicable landing gross weights and for flap settings of 0 degrees and 50 degrees.

COMBAT ALLOWANCE CHARTS.

The Combat Allowance Charts (figure A-26) show the relationship between time and fuel with changes in altitude for two-engine operation with no external load at maximum, military, and normal power settings.

Combat time or fuel may be determined from this chart for a given power setting.

Use of Combat Allowance Charts.

Enter the chart at the combat altitude and the fuel quantity to be used for combat to obtain the time available. Enter at the altitude and time available for combat to obtain the fuel required.

TYPICAL MISSION.

This sample problem combines the use of the charts in this section to plan a typical mission.

FLIGHT PLAN DATA.

A combat mission is to be flown using two pylon tanks which are to be dropped when empty. Prepare a flight plan based on the following data:

1. Distance to combat area 450 n mi
2. Assigned altitudes:
Inbound to combat (cruise-climb) 31,000 ft and above
Outbound from combat (cruise-climb) 36,000 ft. and above
3. Combat at 45,000 ft (maximum power) 5 min
4. Weather (assume Standard Day temperature throughout) CAVU
Winds aloft inbound (31,000 ft and above) 40 kn HW
Winds aloft outbound (36,000 ft and above) 50 kn TW
Field elevation 2000 ft
5. Airplane gross weight:
Operating minimum (includes crew of two, oil, trapped fuel, pylons, and miscellaneous equipment) 29,055 lb
Rockets 1882 lb
Two 300-gallon pylon tanks (empty weight) 283 lb
Maximum usable fuel — internal, external, and pylon tanks (2369 gallons) 15,418 lb
Total gross weight 46,638 lb

TAKEOFF.

Obtain the takeoff distance from the maximum power takeoff distance chart, figure A-5. (Standard Day temperature at 2000 ft is 11°C.) Assume zero wind.

1. Ground roll distance (46,638 lb) 4900 ft
2. Total takeoff distance over 50-foot obstacle 6400 ft
3. Takeoff speed (IAS) 139 kn

INBOUND LEG.

Cruise.

The inbound leg may be determined directly from the Mission Profile chart (figure A-8) for pylon tanks dropped when empty. The profile includes a 996-lb

fuel allowance for start, taxi, and takeoff, as well as the fuel required for climb to and cruise at the cruise-climb altitude.

1. Distance	450 n mi
2. Fuel required (no wind) from profile	7000 lb
3. Time (no wind) from profile	1 hr 7 min
4. Average TAS ("1" ÷ "3")	400 kn
5. Ground speed ("4" + 40 kn)	360 kn
6. Time with wind ("1" ÷ "5")	1 hr 15 min
7. Fuel required (with wind) from profile	7600 lb
8. Cruise speed (cruise-climb altitude)	0.71 Mach No.
9. Cruise power setting	94% rpm (approx)
10. Military power climb speed schedule	(See figure A-9)
11. Gross weight at end of cruise if pylon tanks dropped when empty (46,638 lb - "7" = 283 lb)	38,755 lb

Climb to Combat Altitude.

Maximum power climb to combat altitude (45,000 ft).

1. Distance traveled in climb	65 n mi
2. Gross weight at start of climb from 33,600 ft.	38,755 lb
3. Gross weight at end of climb to 45,000 ft	37,200 lb
4. Fuel used to climb (38,755 lb - 37,200 lb)	1555 lb
5. Time required to climb	9 min
6. Maximum power climb speed schedule	(See figure A-9)

COMBAT.

From the Combat Allowance Chart (figure A-26), obtain the fuel required for combat at 45,000 ft.

1. Combat — maximum power (5 min):	700 lb
2. Gross weight at end of combat 37,200 lb - 700 lb (combat fuel) 1882 lb (rockets)	34,618 lb
Assume zero distance traveled during combat. Determine the fuel remaining at end of combat.	
3. Takeoff, climb, and cruise	7600 lb
4. Climb to combat altitude	1555 lb
5. Combat	700 lb
6. Total fuel used	9855 lb
7. Fuel remaining (15,418 lb - 9855 lb)	5563 lb

OUTBOUND CRUISE — CLIMB.

At the end of combat, the airplane is 515 N Mi (450 + 65) from base at an altitude of 45,000 ft. Enter the Optimum Return Profile Chart (figure A-13) for no external load at the distance from the base, and determine the fuel required and reserve with the existing tailwind. Note that the optimum altitude for start of return at the distance is 35,700 ft; therefore, a recommended descent (with speed brakes open) is made from 45,000 ft to 35,700 ft (time, distance, and fuel consumed are negligible).

1. Distance	515 n mi
2. Fuel required (no wind)	4200 lb
3. Initial cruise altitude	35,700 ft
4. Total time (no wind)	1 hr 16 min
5. Average TAS ("1" ÷ "4")	406 kn
6. Average ground speed ("5" + 50)	456 kn
7. Total time with wind ("1" ÷ "6")	1 hr 8 min
8. Fuel required (wind)	3800 lb
9. Cruise speed	0.71 Mach No.
10. Power setting	(See figure A-13)
11. Reserve over base at 38,700-ft altitude (5563 lb - "8")	1763 lb

DESCENT.

Obtain the fuel required to descend to base from the Descent Chart (figure A-23).

1. Recommended descent, speed brakes open, from 38,700 ft	50 lb
2. Time to descend	2 min
3. Descent speed, using idle power and speed brakes open	0.70 Mach No.
4. Fuel reserve for loiter and landing (1763 lb - 50 lb)	1713 lb
5. Airplane gross weight for landing	30,768 lb

LANDING.

Obtain the landing distance from the Landing Distance Chart, figure A-24. Use 2000-ft altitude, 11°C, and no wind.

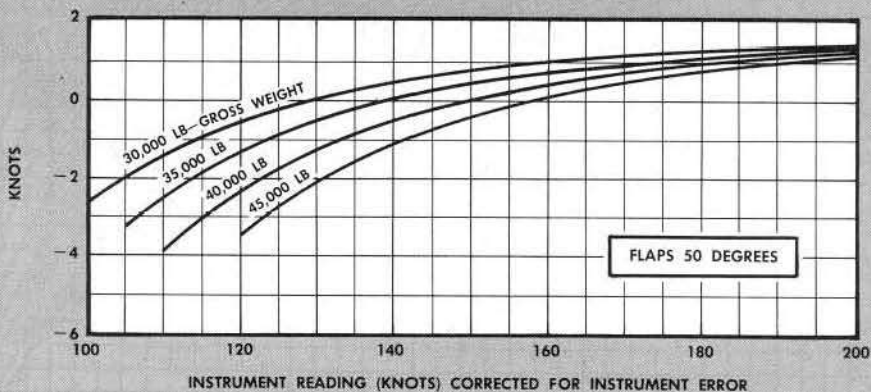
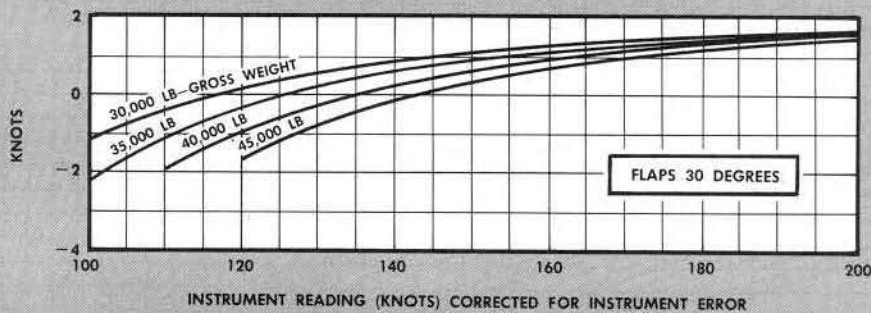
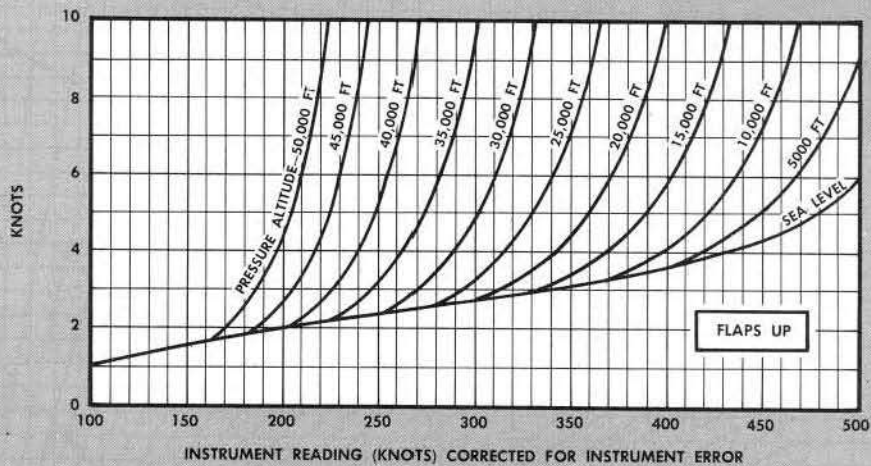
1. Ground roll distance	3400 ft
2. Total distance over 50-ft obstacle	4600 ft
3. Approach speed (IAS)	140 kn
4. 50-ft obstacle speed (IAS)	121 kn
5. Touchdown speed (IAS)	112 kn
The sum of all the time required gives the time from takeoff to landing	
	2 hr 39 min

AIRSPEED POSITION CORRECTION

MODEL: F-89D

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56J35-35
OR
ENGINE(S): (2) J35-47FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

AIRSPEED POSITION CORRECTION



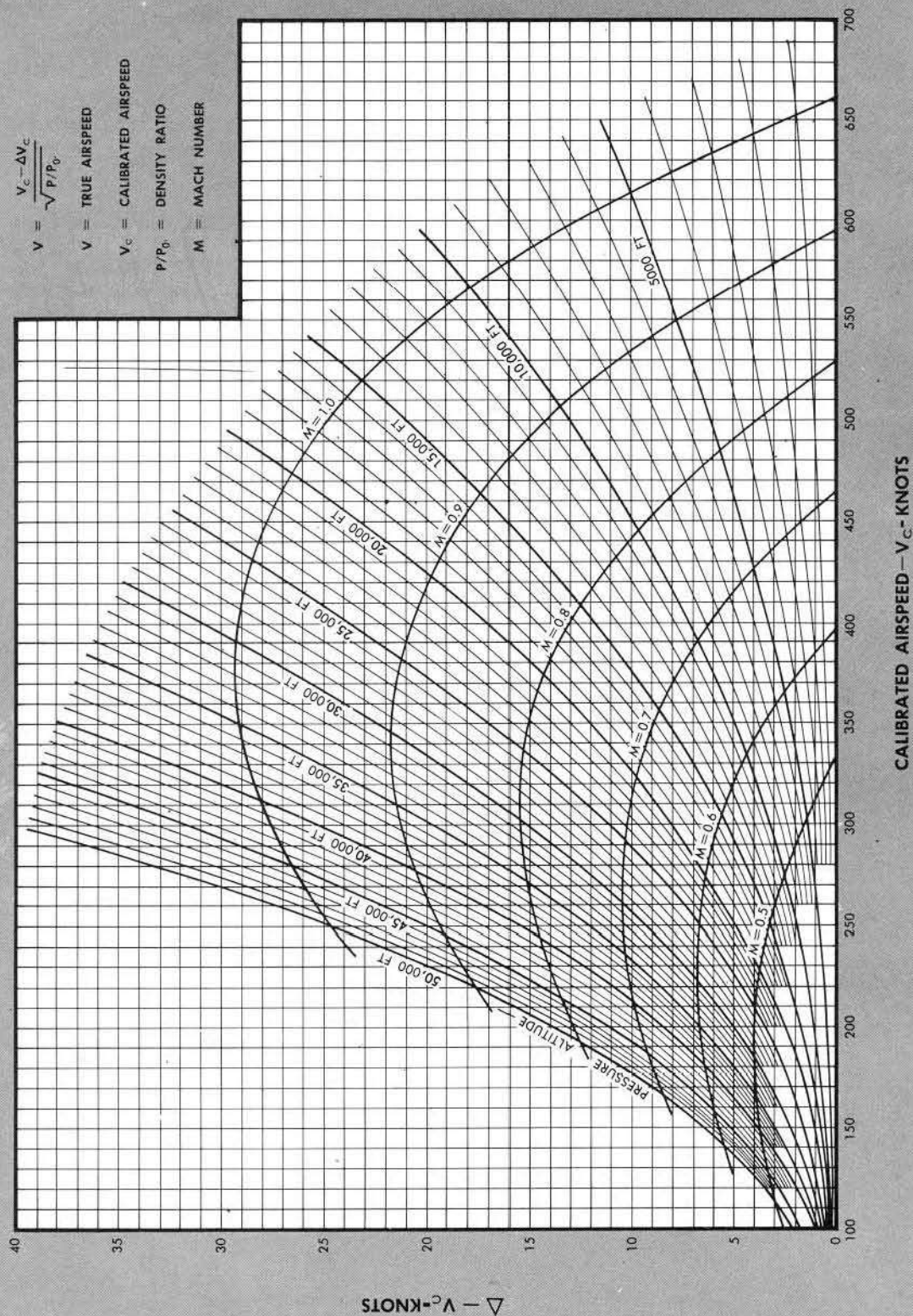
REMARKS:

1. ADD CORRECTION TO CORRECTED INSTRUMENT READING (IAS) TO OBTAIN CALIBRATED AIRSPEED.
2. GEAR UP OR DOWN.

D-310

Figure A-1.

COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED



D-311

Figure A-2.

TEMPERATURE CORRECTION FOR COMPRESSIBILITY

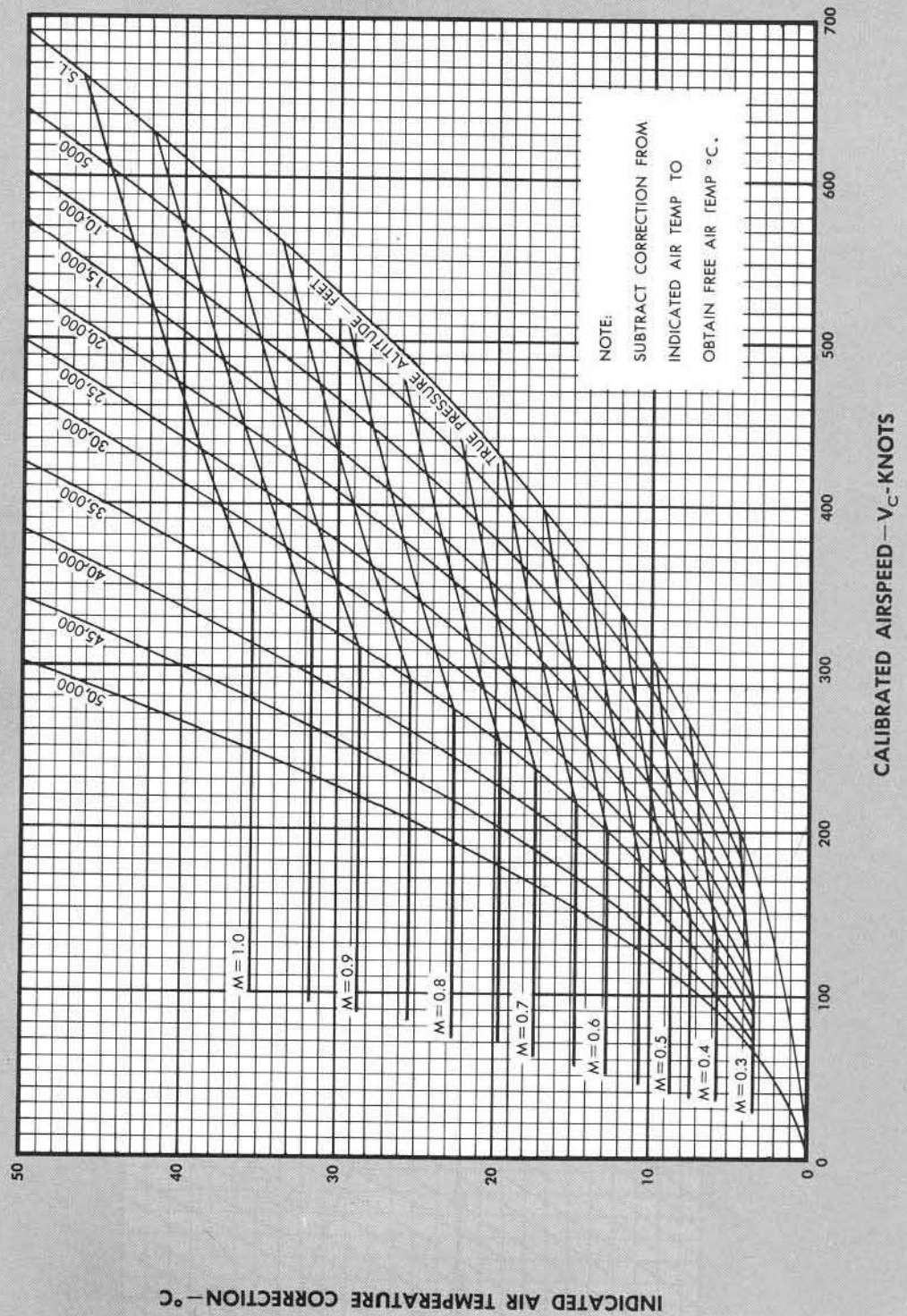
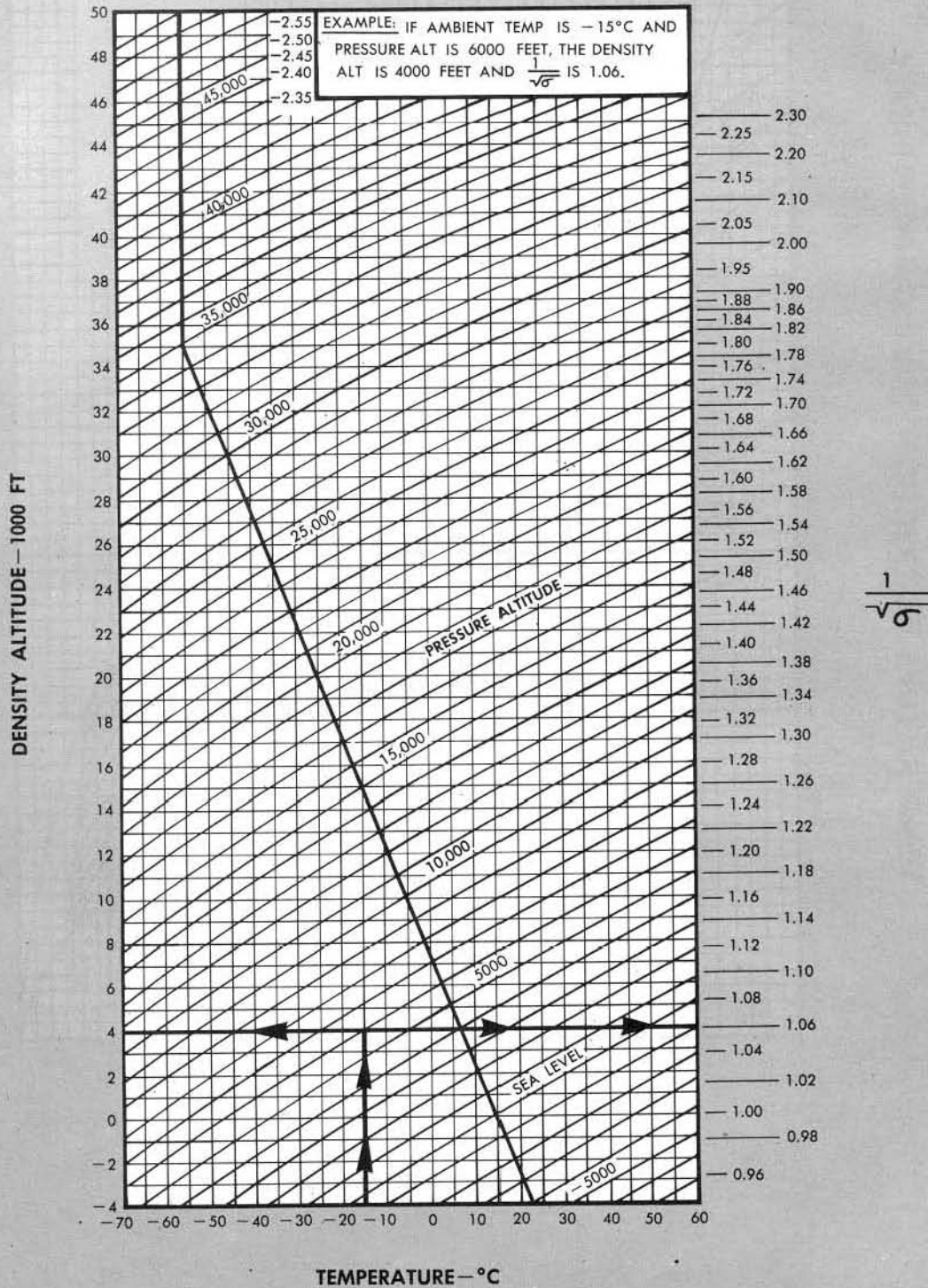


Figure A-3.

DENSITY ALTITUDE CHART



D-313

Figure A-4.

TAKEOFF DISTANCE

MODEL: F-89D

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS

J35-35

OR

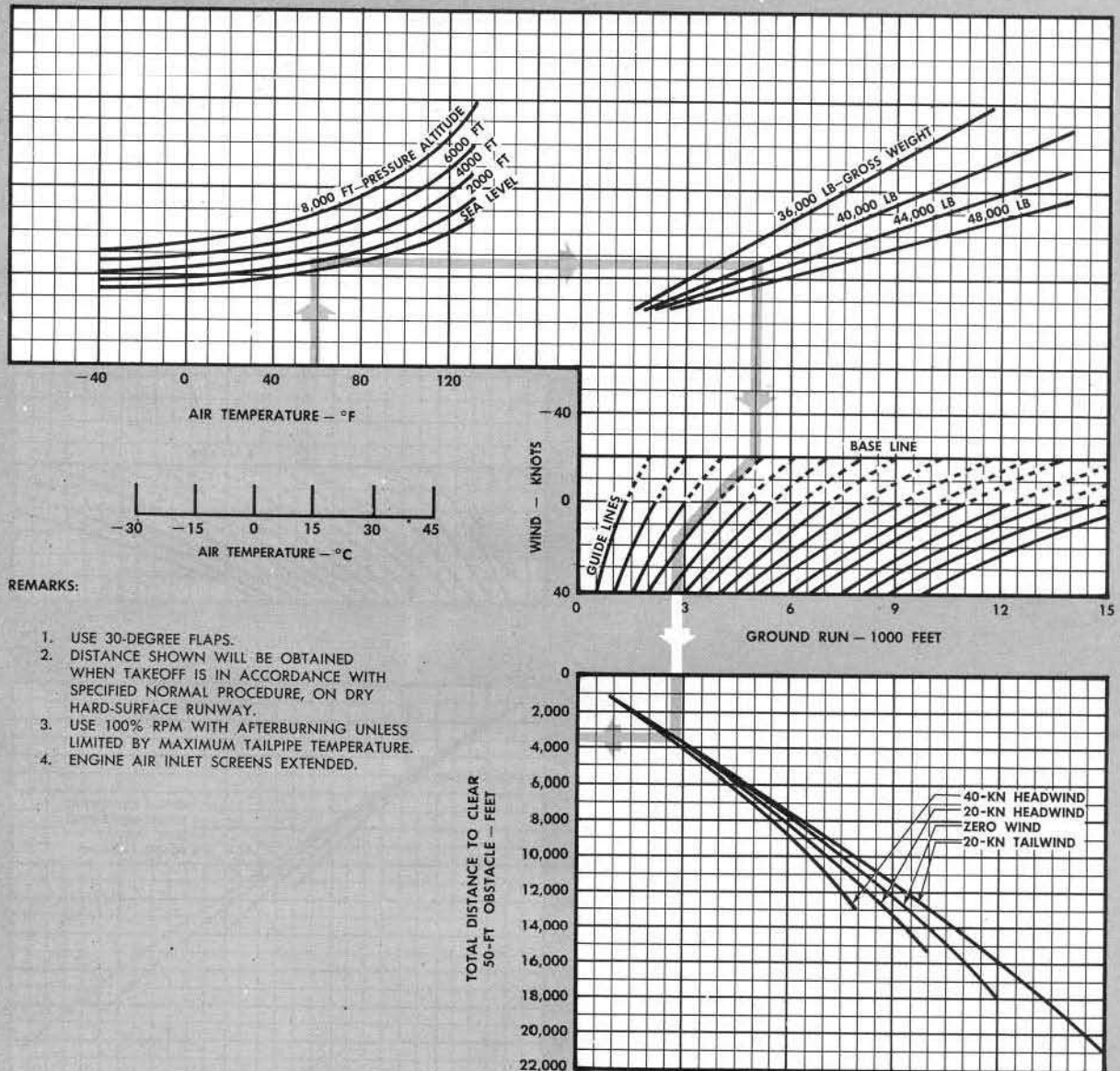
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL



D-314

GROSS WEIGHT	IAS — KNOTS		
	NOSE WHEEL OFF	TAKEOFF	50-FT OBSTACLE
36,000 LB	117	122	133
40,000 LB	124	129	141
44,000 LB	130	135	147
46,638 LB	134	139	151

Figure A-5 (Sheet 1 of 3 Sheets).

TAKEOFF DISTANCEMODEL: **F-89D****MILITARY POWER
WITH OR WITHOUT PYLON TANKS****J35-35**

OR

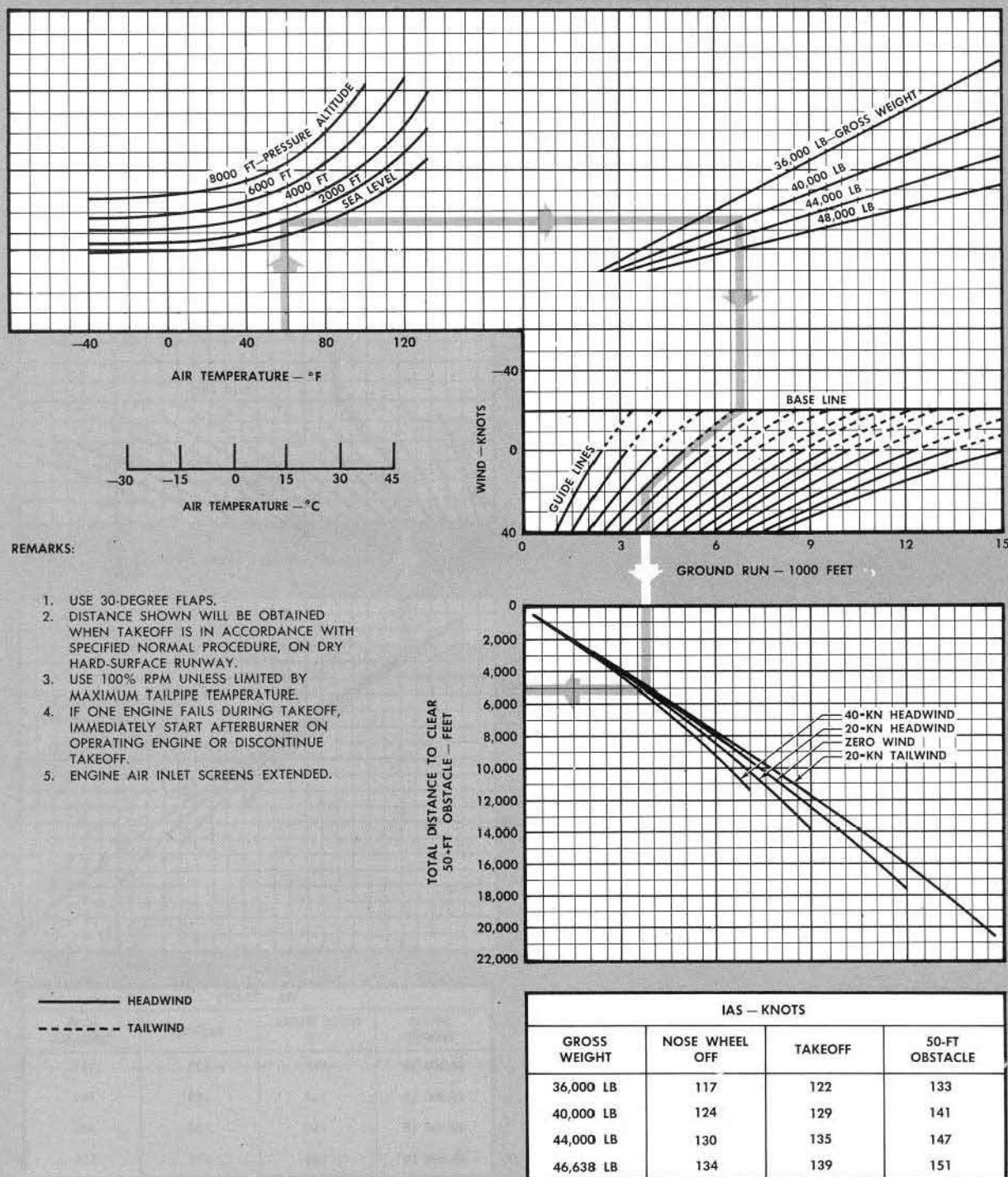
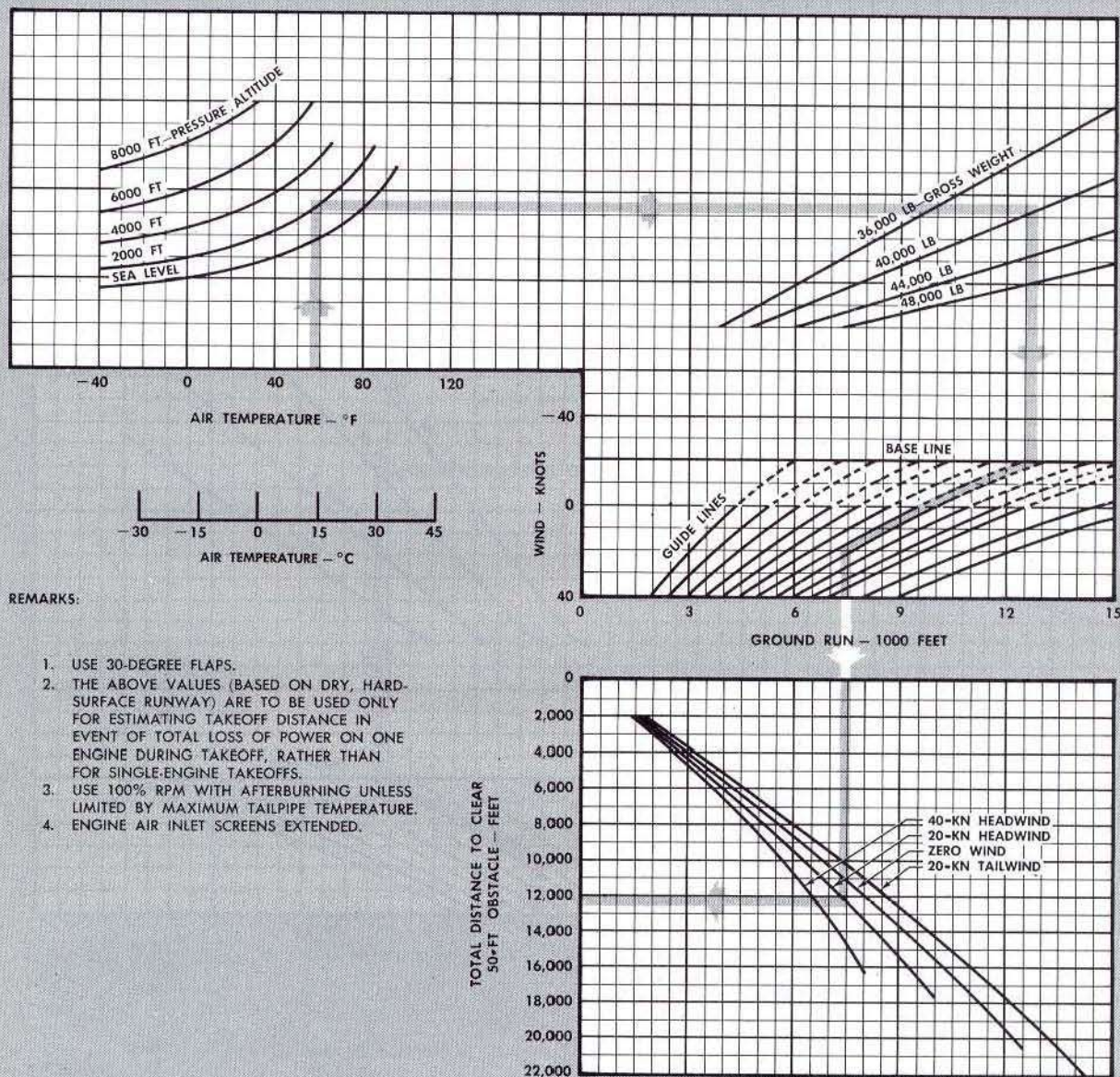
ENGINE(S): (2) **J35-47**DATA BASIS: **FLIGHT TEST**FUEL GRADE: **JP-4**DATE: **15 MARCH 56**FUEL DENSITY: **6.5 LB/US GAL**

Figure A-5 (Sheet 2 of 3 Sheets).

TAKEOFF DISTANCEMODEL: **F-89D****ONE ENGINE OPERATING—MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS**DATA BASIS: **FLIGHT TEST**DATE: **15 MARCH 56****J35-35**

OR

ENGINE(S): (2) **J35-47**FUEL GRADE: **JP-4**FUEL DENSITY: **6.5 LB/US GAL**

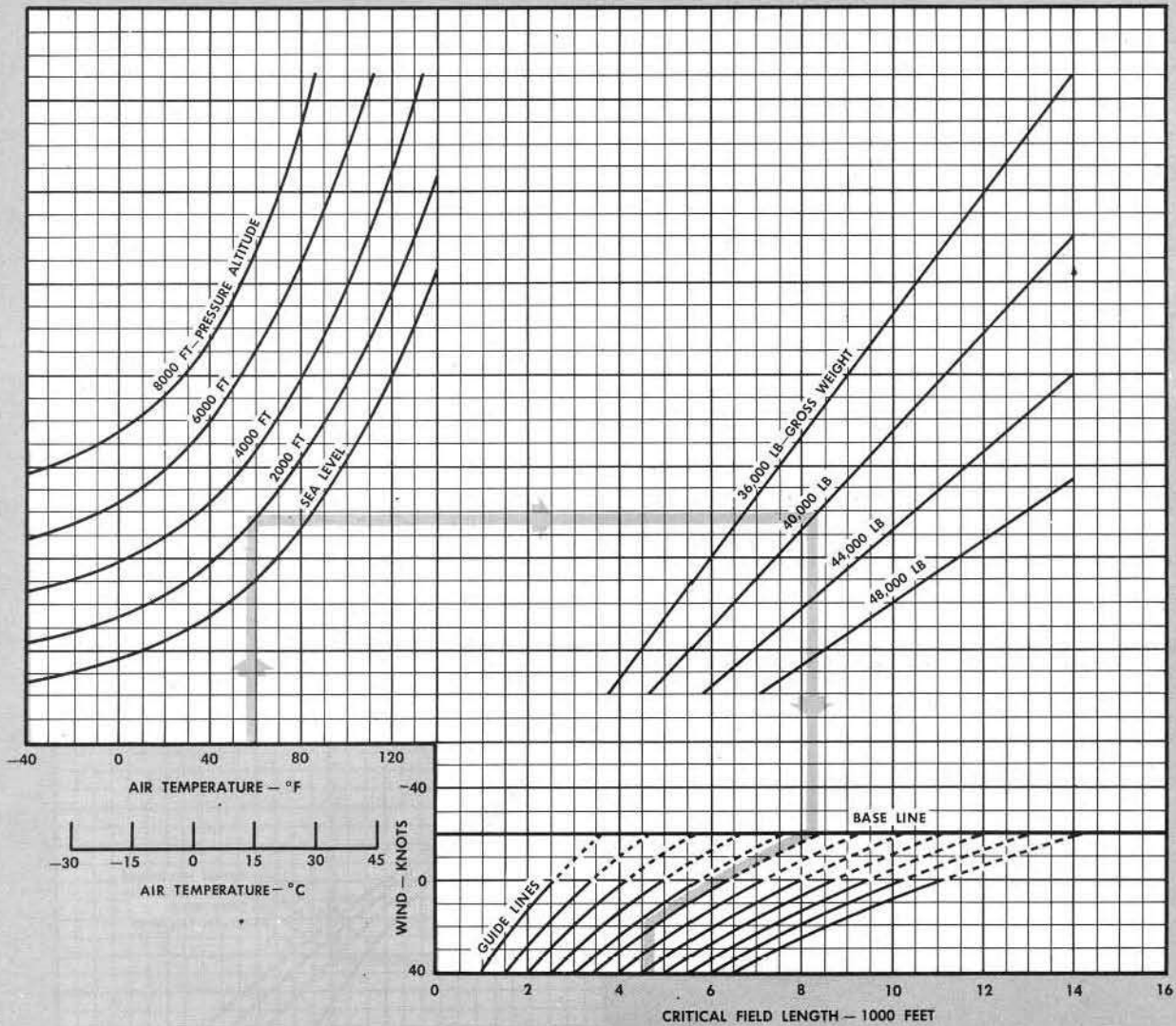
REMARKS:

1. USE 30-DEGREE FLAPS.
2. THE ABOVE VALUES (BASED ON DRY, HARD-SURFACE RUNWAY) ARE TO BE USED ONLY FOR ESTIMATING TAKEOFF DISTANCE IN EVENT OF TOTAL LOSS OF POWER ON ONE ENGINE DURING TAKEOFF, RATHER THAN FOR SINGLE-ENGINE TAKEOFFS.
3. USE 100% RPM WITH AFTERBURNING UNLESS LIMITED BY MAXIMUM TAILPIPE TEMPERATURE.
4. ENGINE AIR INLET SCREENS EXTENDED.

GROSS WEIGHT	IAS — KNOTS		
	NOSE WHEEL OFF	TAKEOFF	50-FT OBSTACLE
36,000 LB	117	122	133
40,000 LB	124	129	141
44,000 LB	130	135	147
46,638 LB	134	139	151

D-316

Figure A-5 (Sheet 3 of 3 Sheets).

CRITICAL FIELD LENGTH**MAXIMUM POWER****WITH OR WITHOUT PYLON TANKS****J35-35****OR****ENGINE(S): (2) J35-47****MODEL: F-89D****DATA BASIS: FLIGHT TEST****DATE: 15 MARCH 56****FUEL GRADE: JP-4****FUEL DENSITY: 6.5 LB/US GAL****REMARKS:**

1. ALL VALUES SHOWN ON CHART ARE BASED ON DRY HARD-SURFACE RUNWAY, 30-DEGREE FLAPS, AND SPEED BRAKES INOPERATIVE.
2. THREE SECONDS ALLOWED FOR PILOT RECOGNITION OF ENGINE FAILURE; AT THE END OF THE THREE SECONDS, THROTTLES ARE CUT AND BRAKES APPLIED.
3. ENGINE INLET SCREENS EXTENDED.

———— HEADWIND
 - - - - - TAILWIND

D-317

Figure A-6.

MAXIMUM REFUSAL SPEEDS

MODEL: F-89D

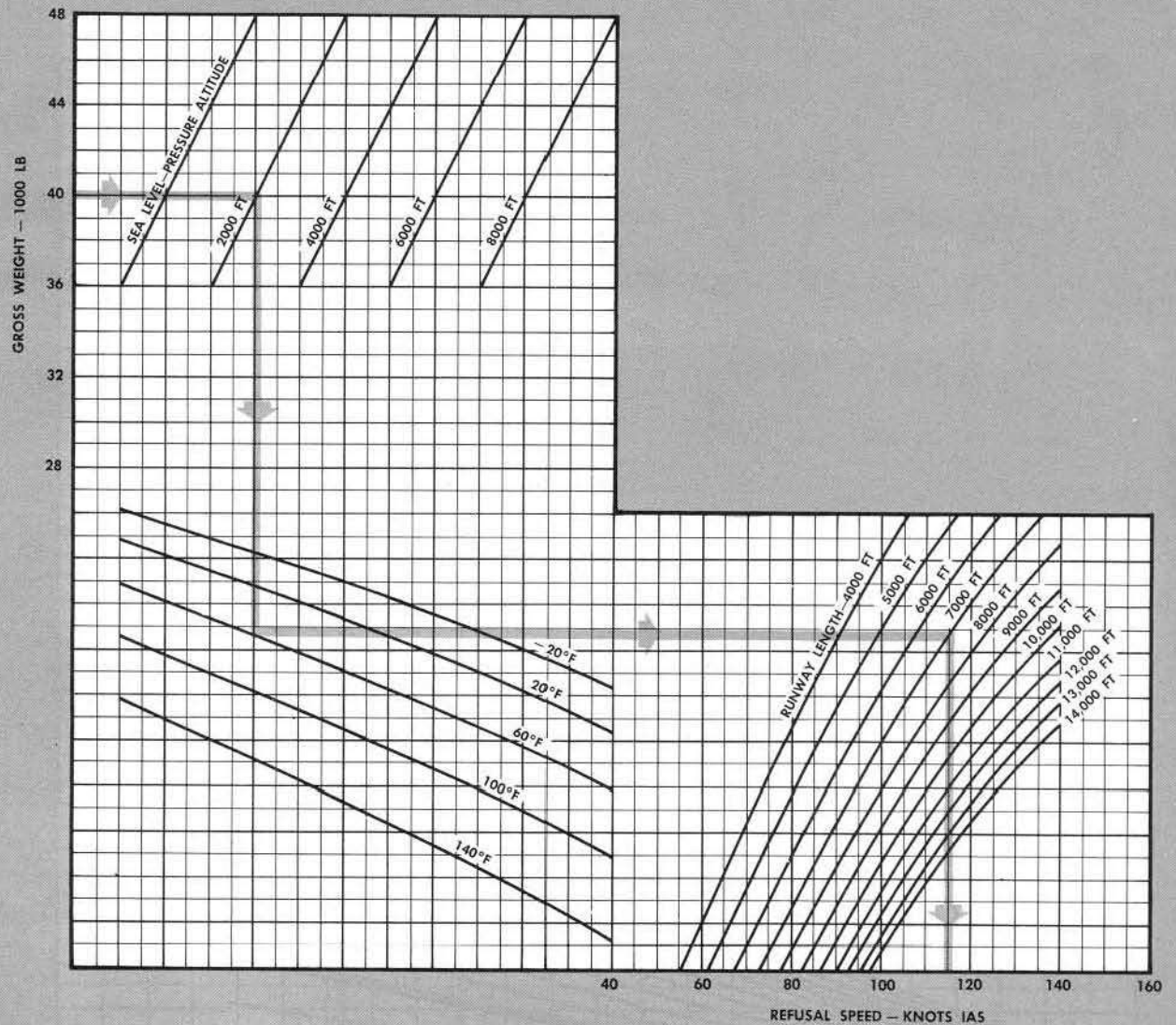
MAXIMUM POWER
WITH OR WITHOUT PYLON TANKSJ35-35
OR
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

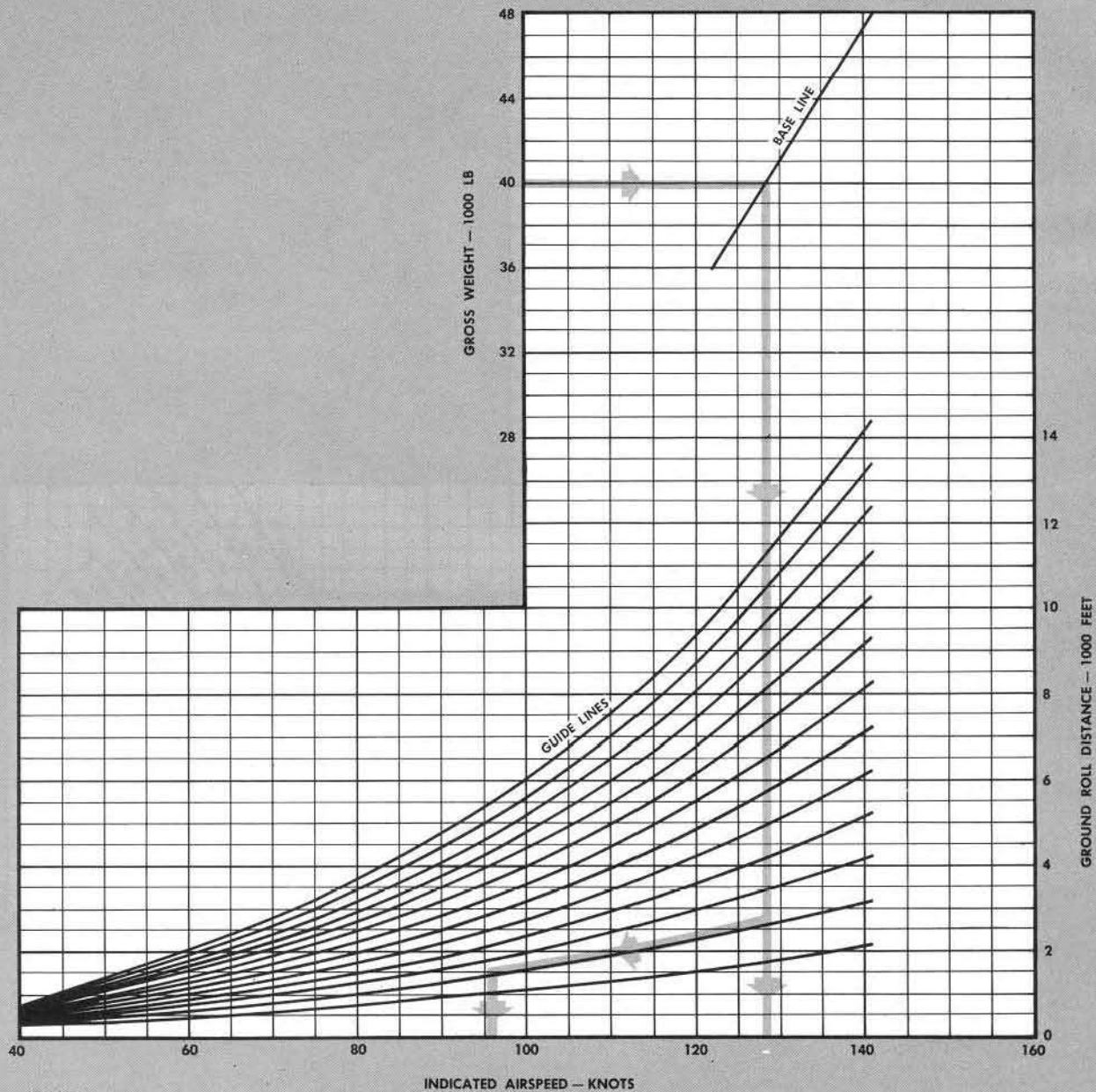
1. ABOVE VALUES ARE BASED ON DRY HARD-SURFACE RUNWAY, USING SPECIFIED NORMAL TAKEOFF PROCEDURE UP TO POINT OF ENGINE FAILURE AND OPERATION IN ACCORDANCE WITH SECTION III AFTER ENGINE FAILURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

D-318

Figure A-7.

VELOCITY DURING TAKEOFF GROUND RUN

MODEL: F-89D

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKSENGINE(S): (2) J35-35
OR
J35-47DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

REMARKS:

1. VELOCITIES SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

D-319

Figure A-8 (Sheet 1 of 2 Sheets).

VELOCITY DURING TAKEOFF GROUND RUN

MODEL: F-89D

MILITARY POWER
WITH OR WITHOUT PYLON TANKS

J35-35

OR

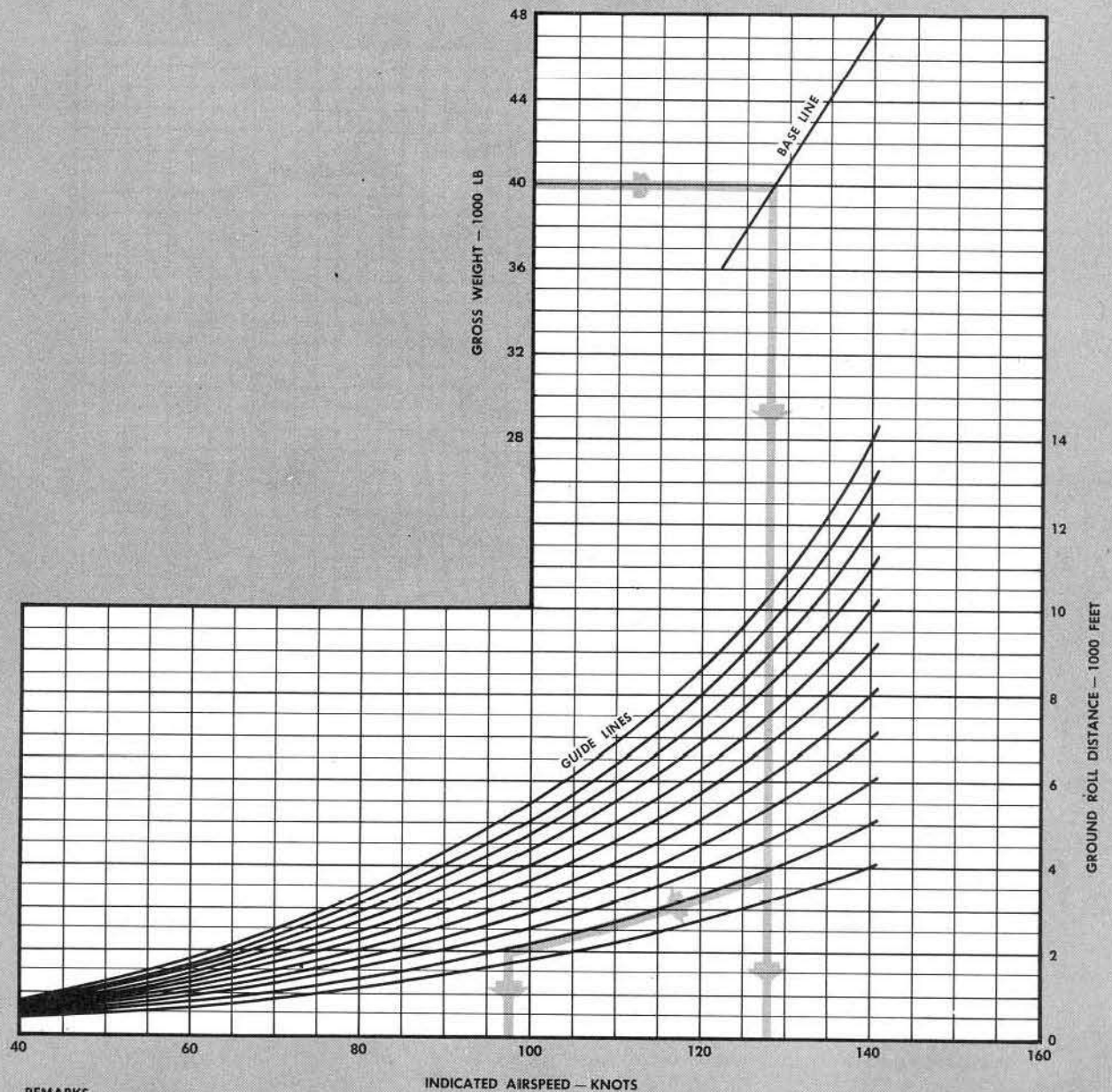
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. VELOCITIES SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

D-320

Figure A-8 (Sheet 2 of 2 Sheets).

BEST CLIMB PERFORMANCE

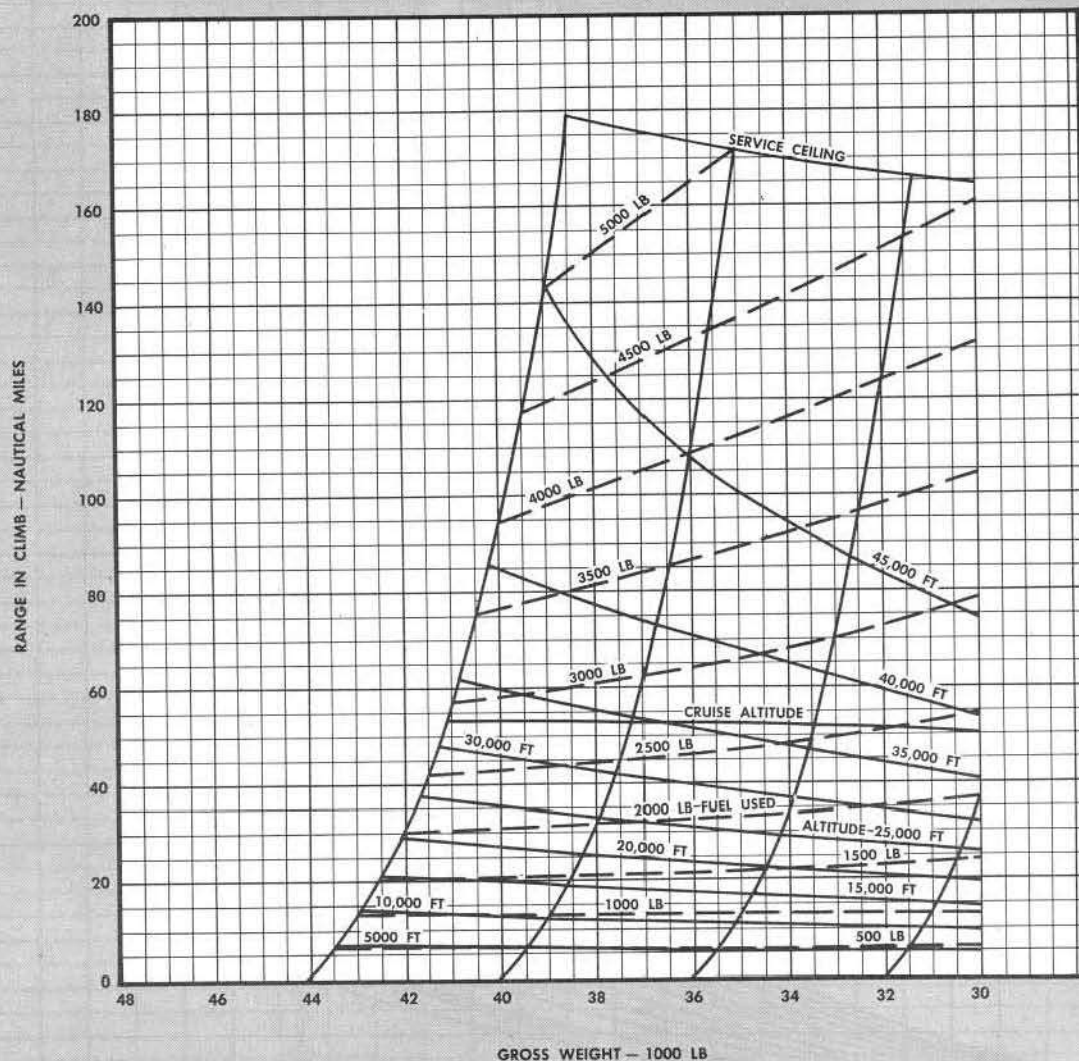
MODEL: F-89D

MAXIMUM POWER
NO EXTERNAL LOADDATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56J35-35
OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

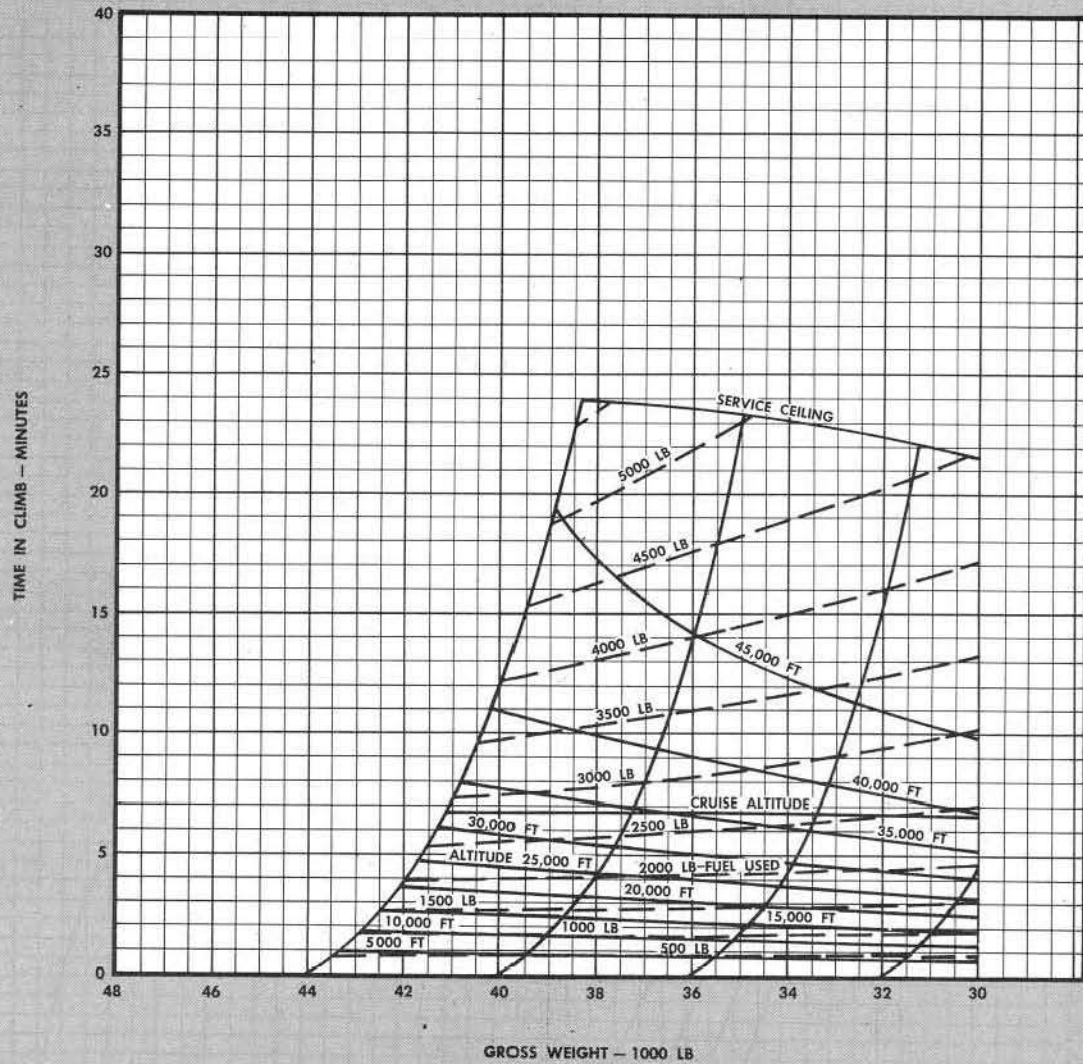
1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-321

Figure A-9 (Sheet 1 of 12 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

MAXIMUM POWER
NO EXTERNAL LOADDATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56J35-35
OR
ENGINE(S): (2) J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-322

Figure A-9 (Sheet 2 of 12 Sheets).

BEST CLIMB SPEED

MODEL: F-89D

MAXIMUM POWER
NO EXTERNAL LOAD

J35-35

OR

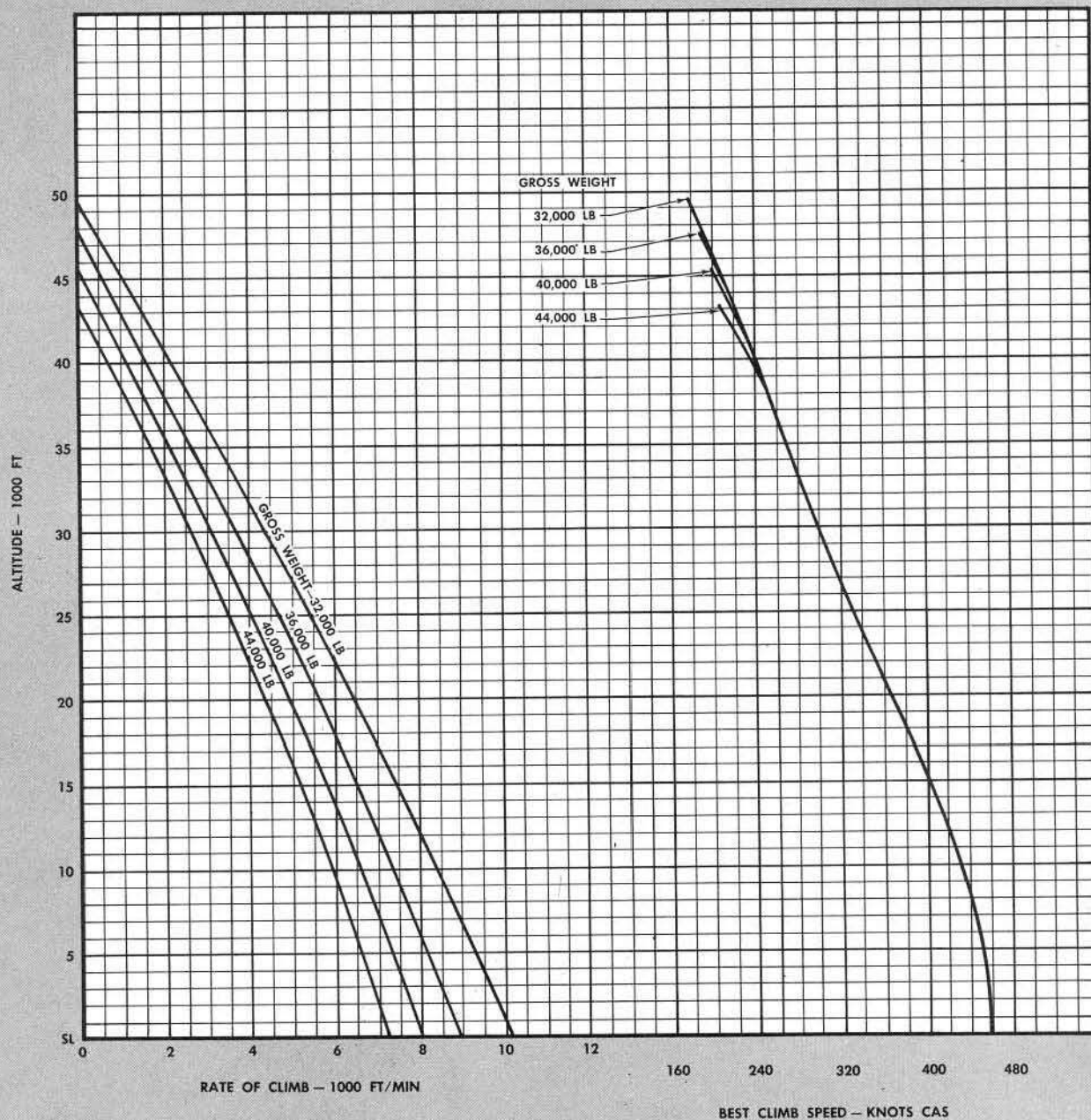
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

D-323

Figure A-9 (Sheet 3 of 12 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

MILITARY POWER
NO EXTERNAL LOAD

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

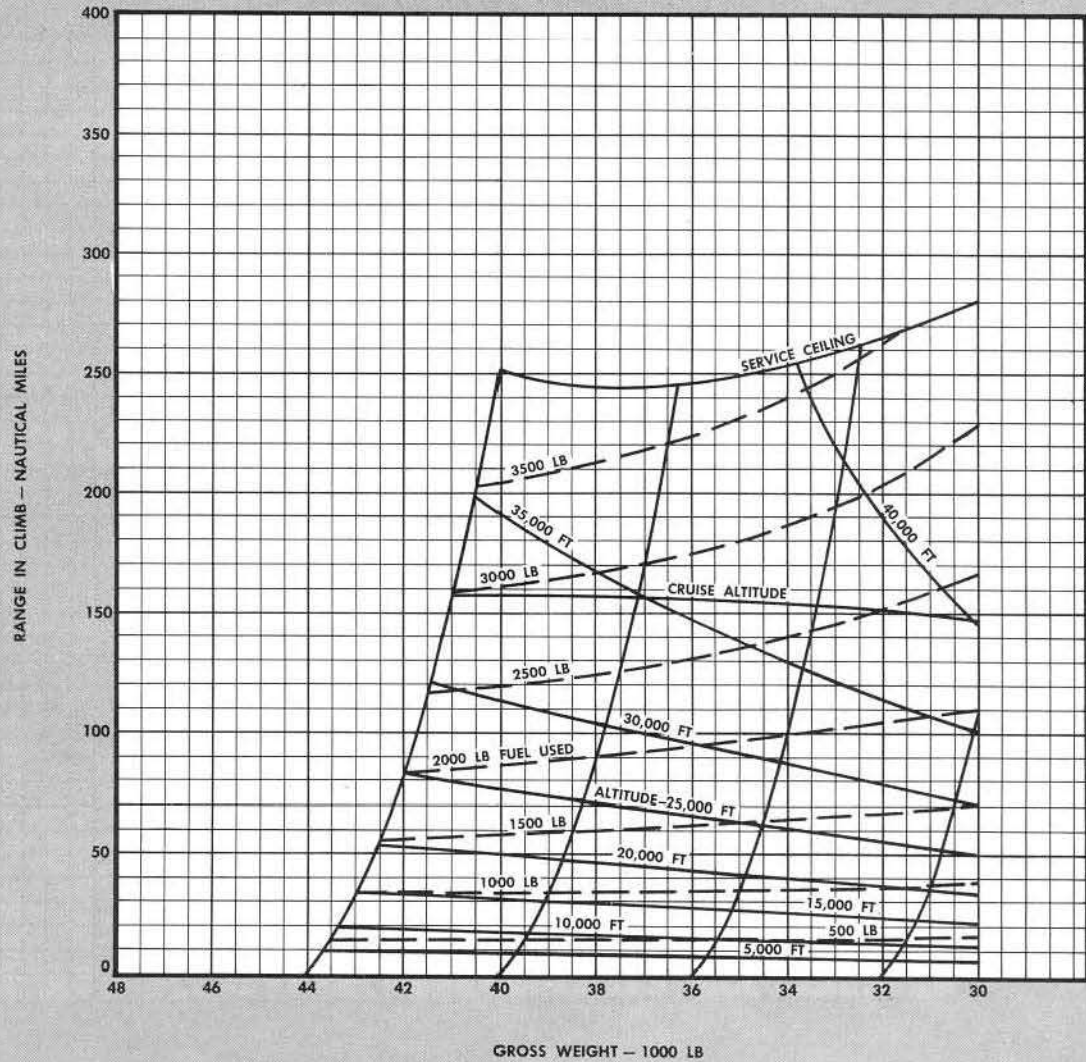
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-324

Figure A-9 (Sheet 4 of 12 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

MILITARY POWER
NO EXTERNAL LOAD

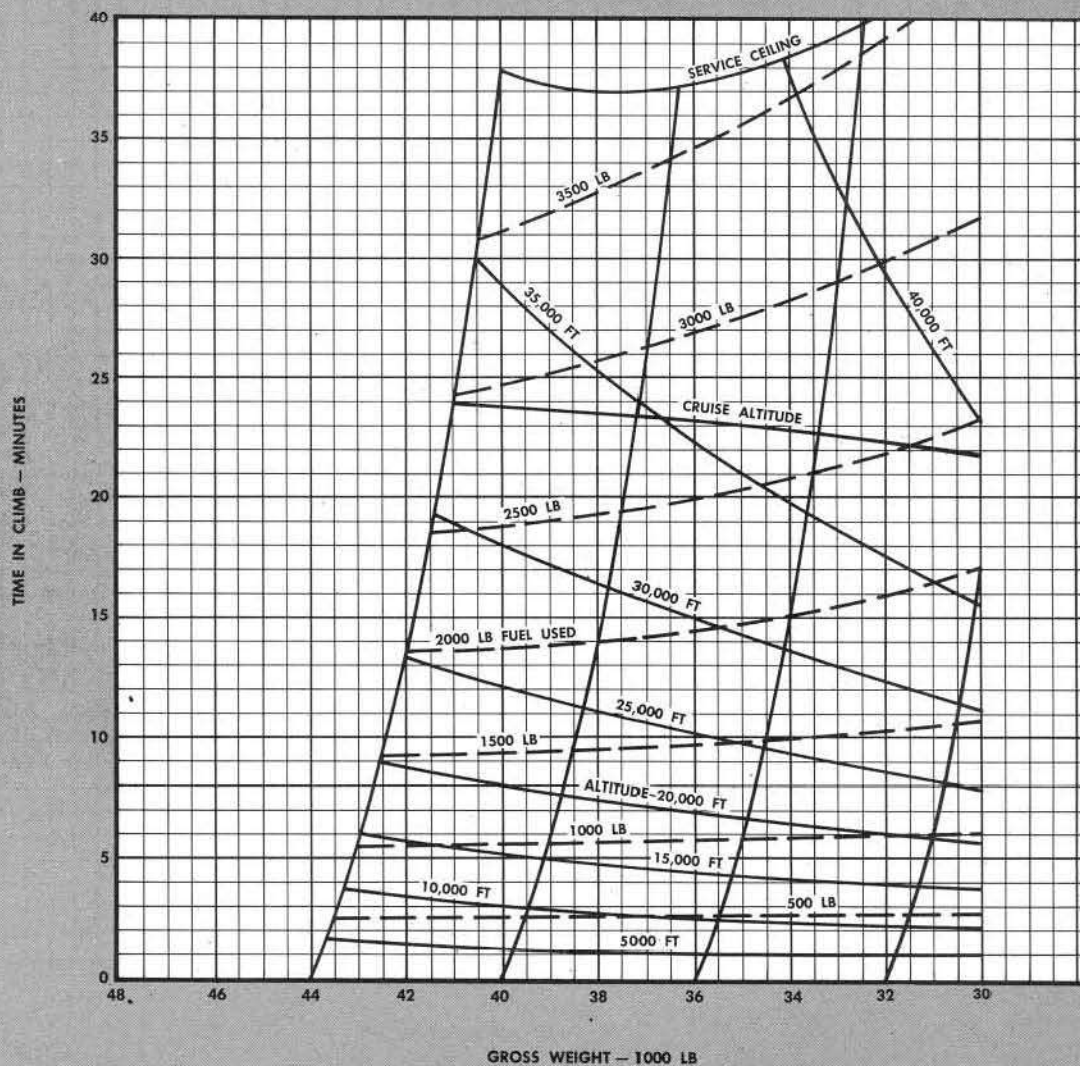
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 908 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-325

Figure A-9 (Sheet 5 of 12 Sheets).

BEST CLIMB SPEED

MODEL: F-89D

MILITARY POWER
NO EXTERNAL LOAD

J35-35

OR

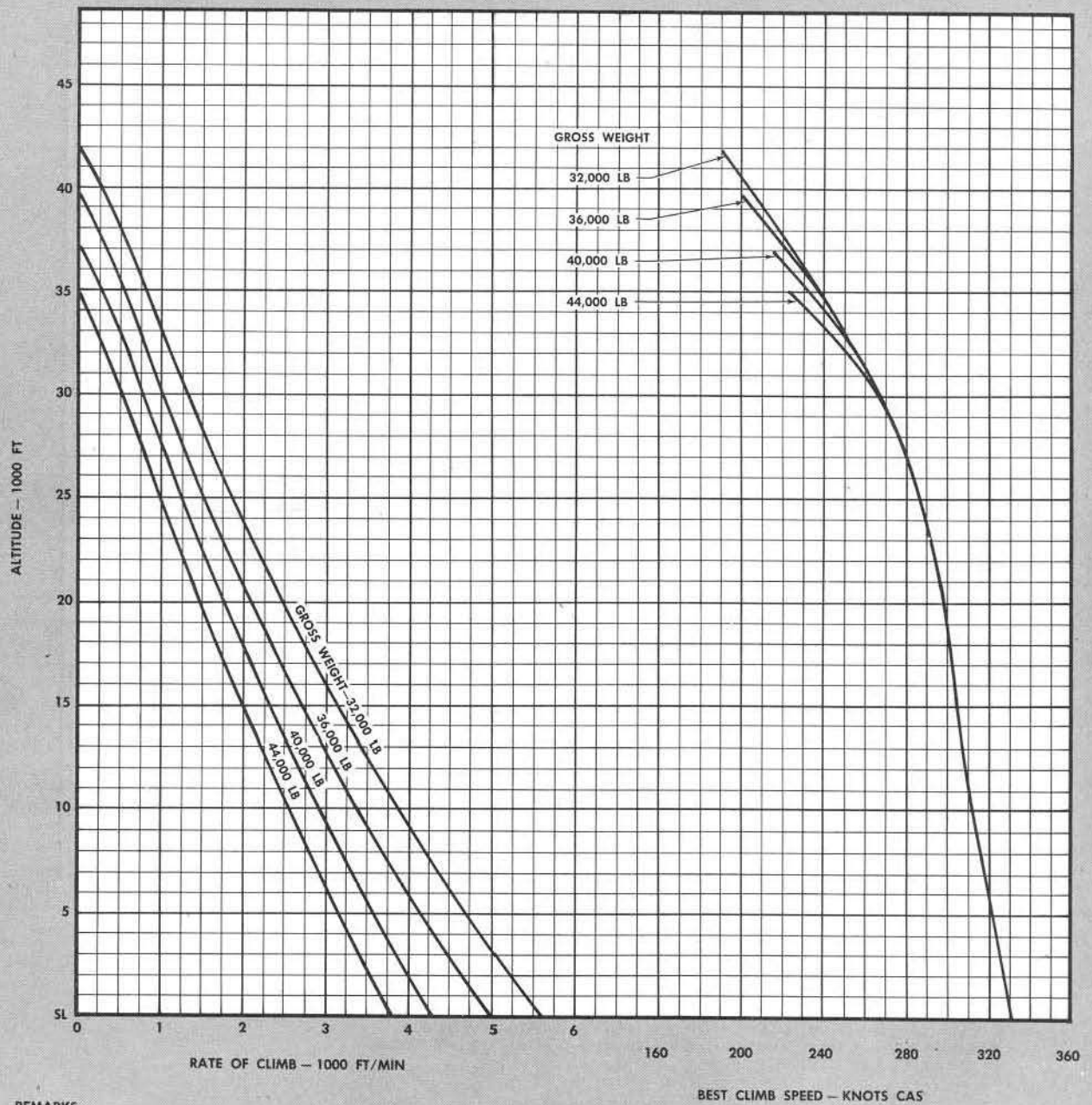
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

D-326

Figure A-9 (Sheet 6 of 12 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

NORMAL POWER
NO EXTERNAL LOAD

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

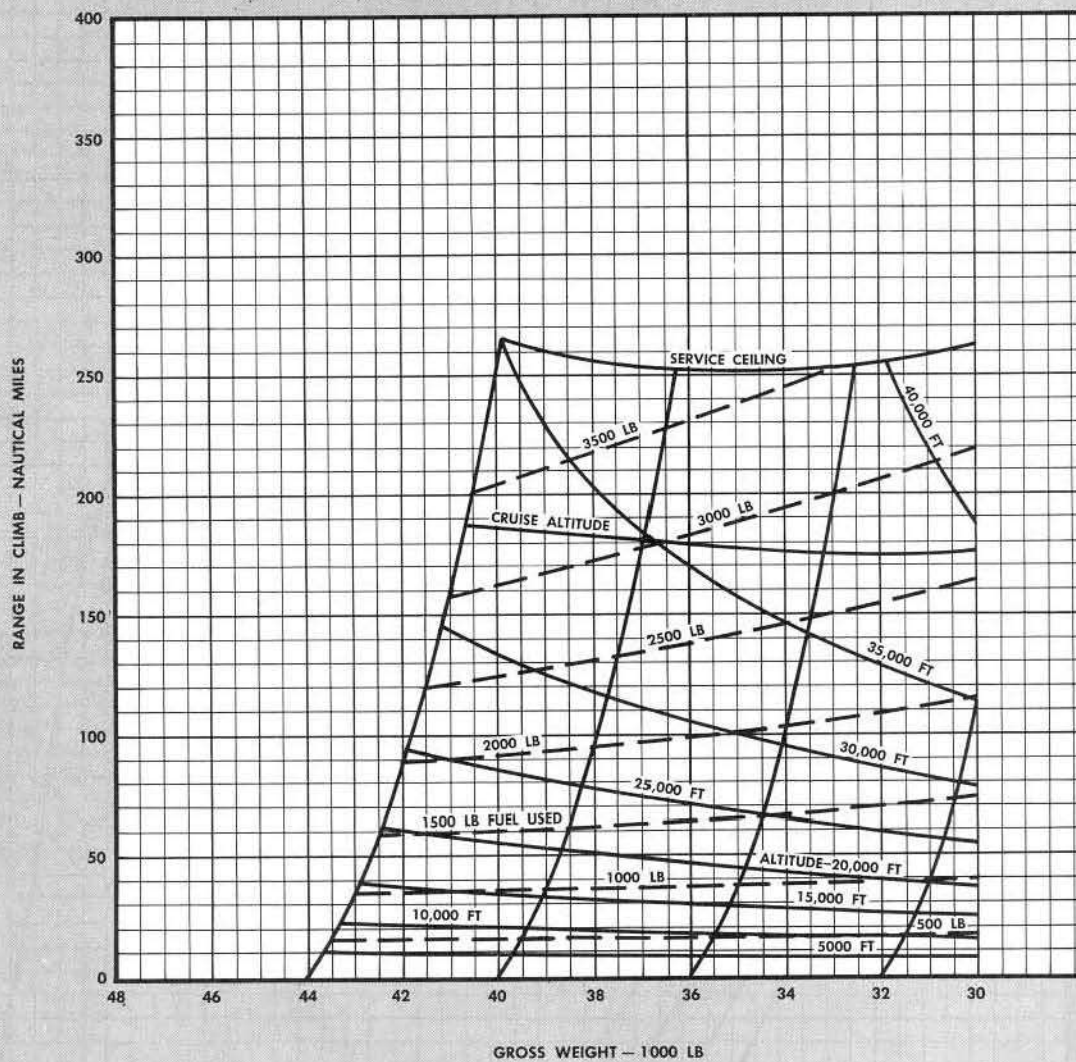
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-327

Figure A-9 (Sheet 7 of 12 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

NORMAL POWER
NO EXTERNAL LOAD

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

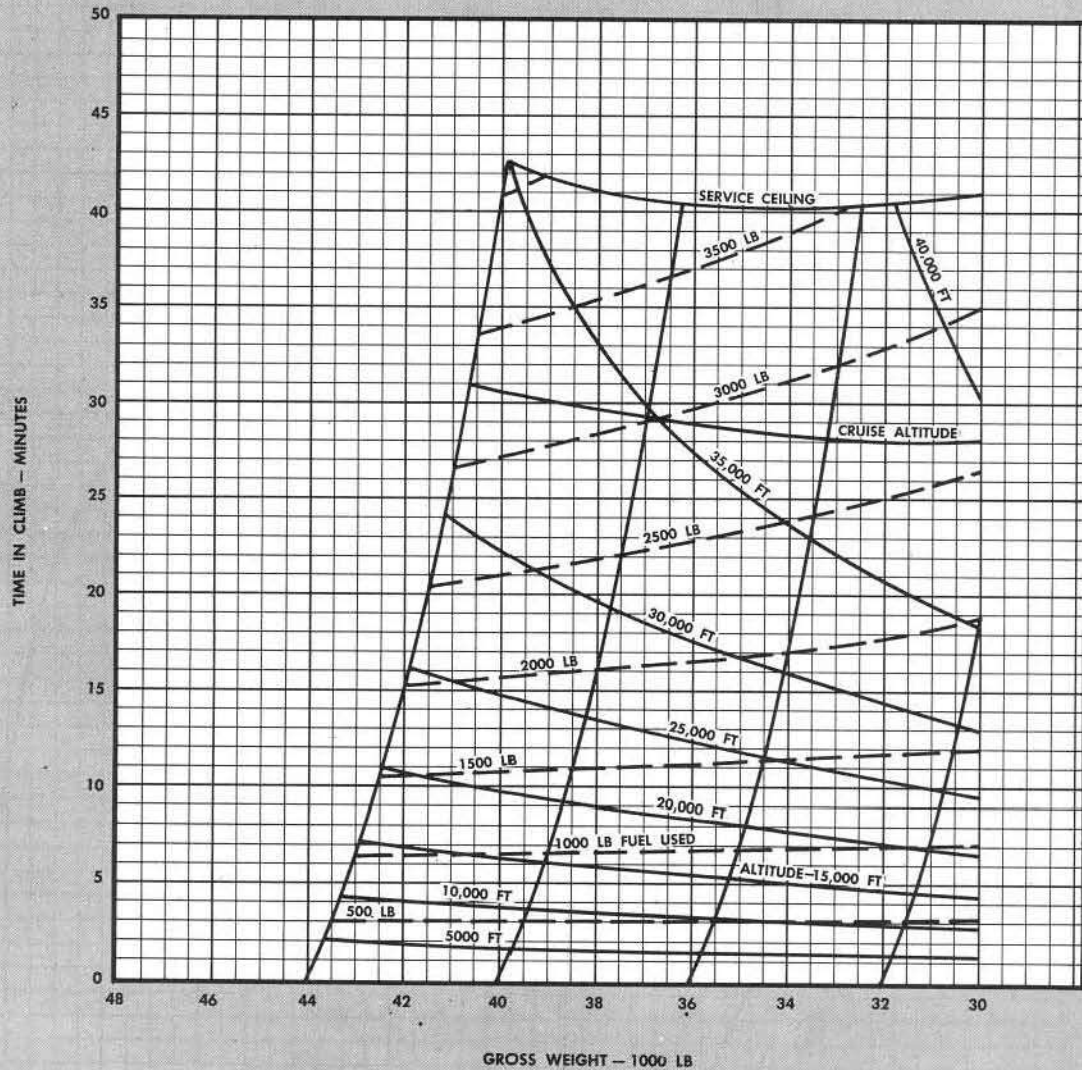
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-328

Figure A-9 (Sheet 8 of 12 Sheets).

BEST CLIMB SPEED

MODEL: F-89D

NORMAL POWER
NO EXTERNAL LOAD

J35-35

OR

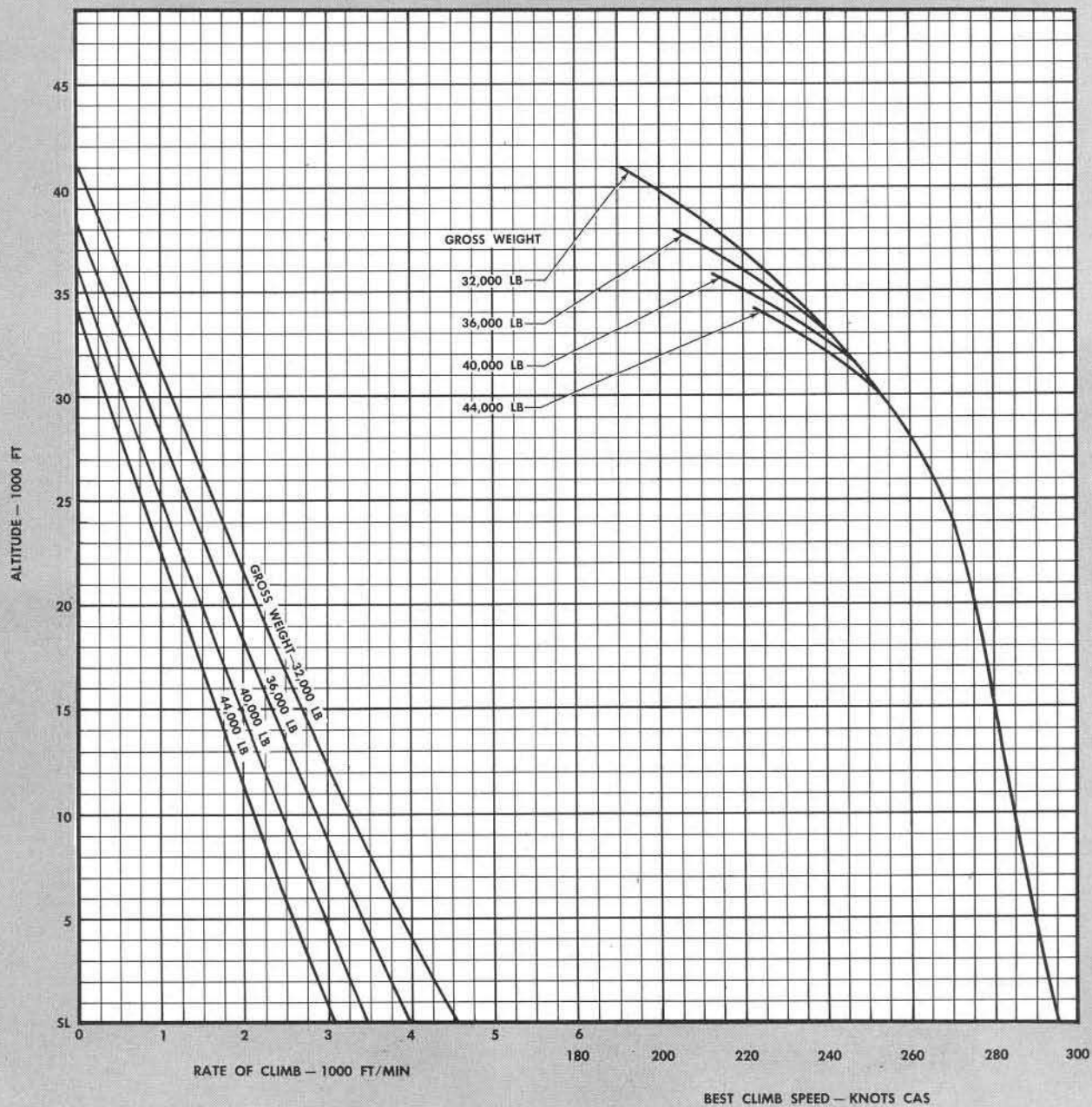
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

D-329

Figure A-9 (Sheet 9 of 12 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

ONE ENGINE OPERATING—MAXIMUM POWER
NO EXTERNAL LOAD

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

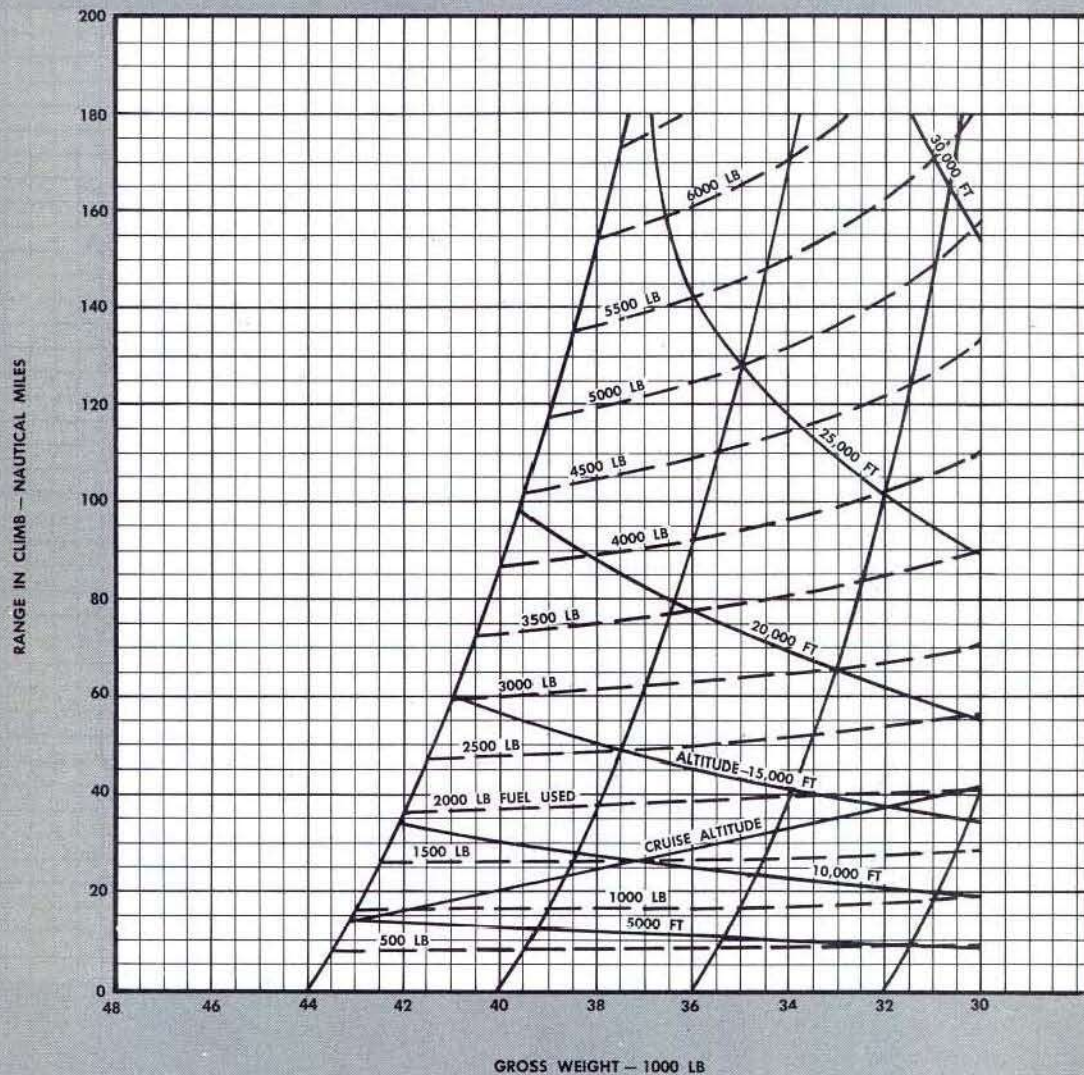
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-330

Figure A-9 (Sheet 10 of 12 Sheets).

BEST CLIMB PERFORMANCEONE ENGINE OPERATING—MAXIMUM POWER
NO EXTERNAL LOAD

MODEL: F-89D

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

J35-35

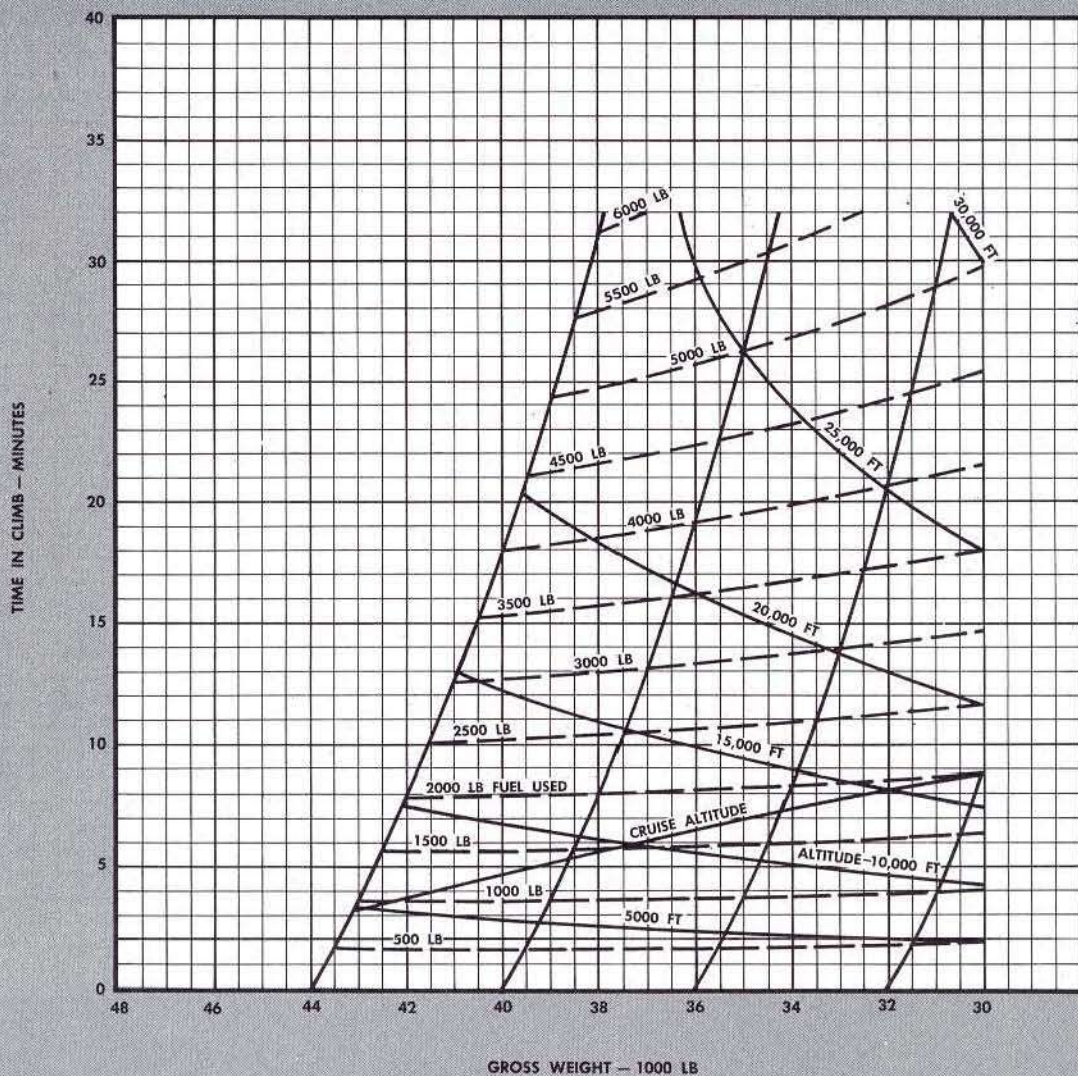
OR

J35-47

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-331

Figure A-9 (Sheet 11 of 12 Sheets).

BEST CLIMB SPEED

MODEL: F-89D

ONE ENGINE OPERATING—MAXIMUM POWER
NO EXTERNAL LOAD

J35-35

OR

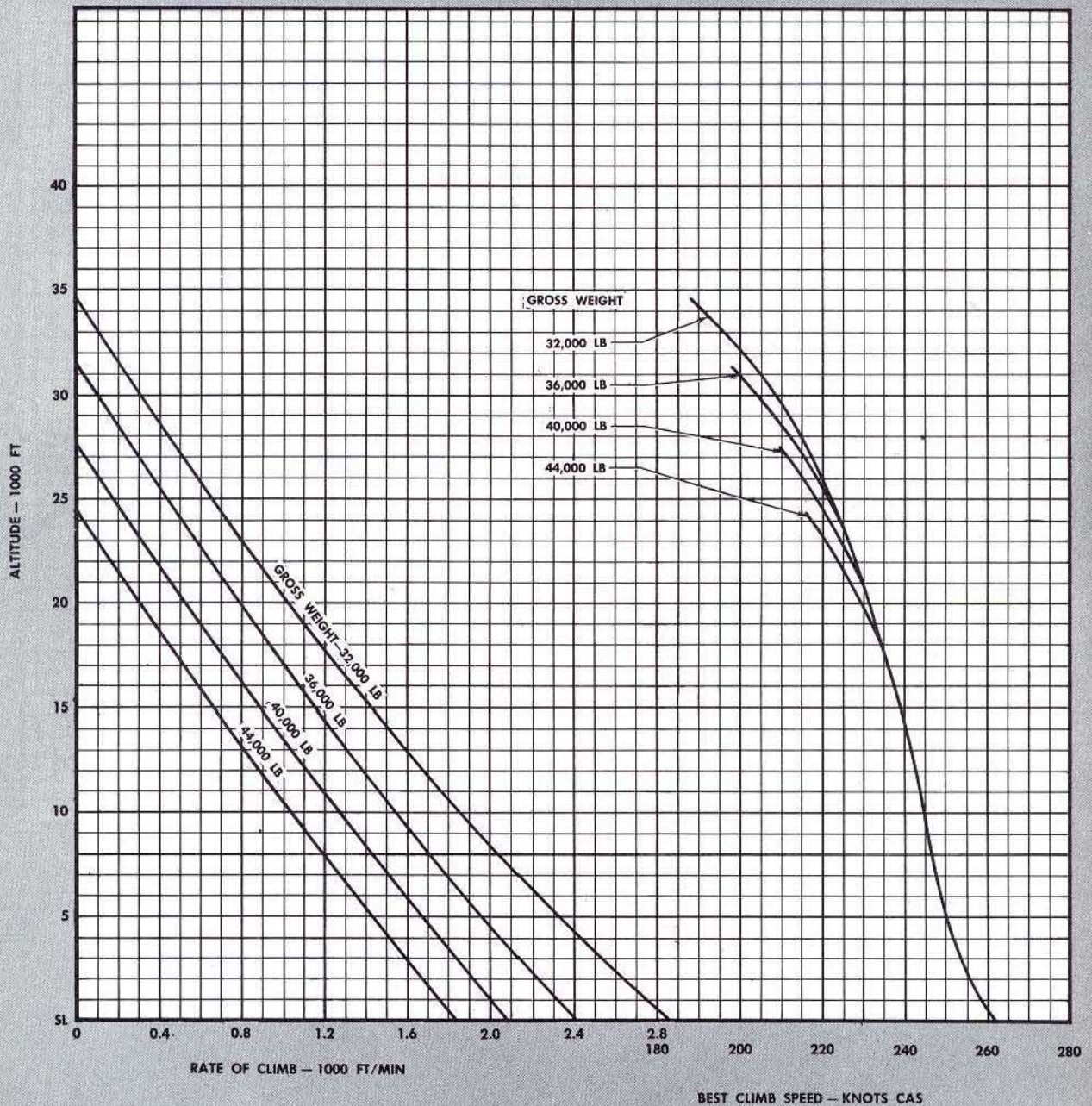
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

D-332

Figure A-9 (Sheet 12 of 12 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

SEA LEVEL
NO EXTERNAL LOAD

J35-35

OR

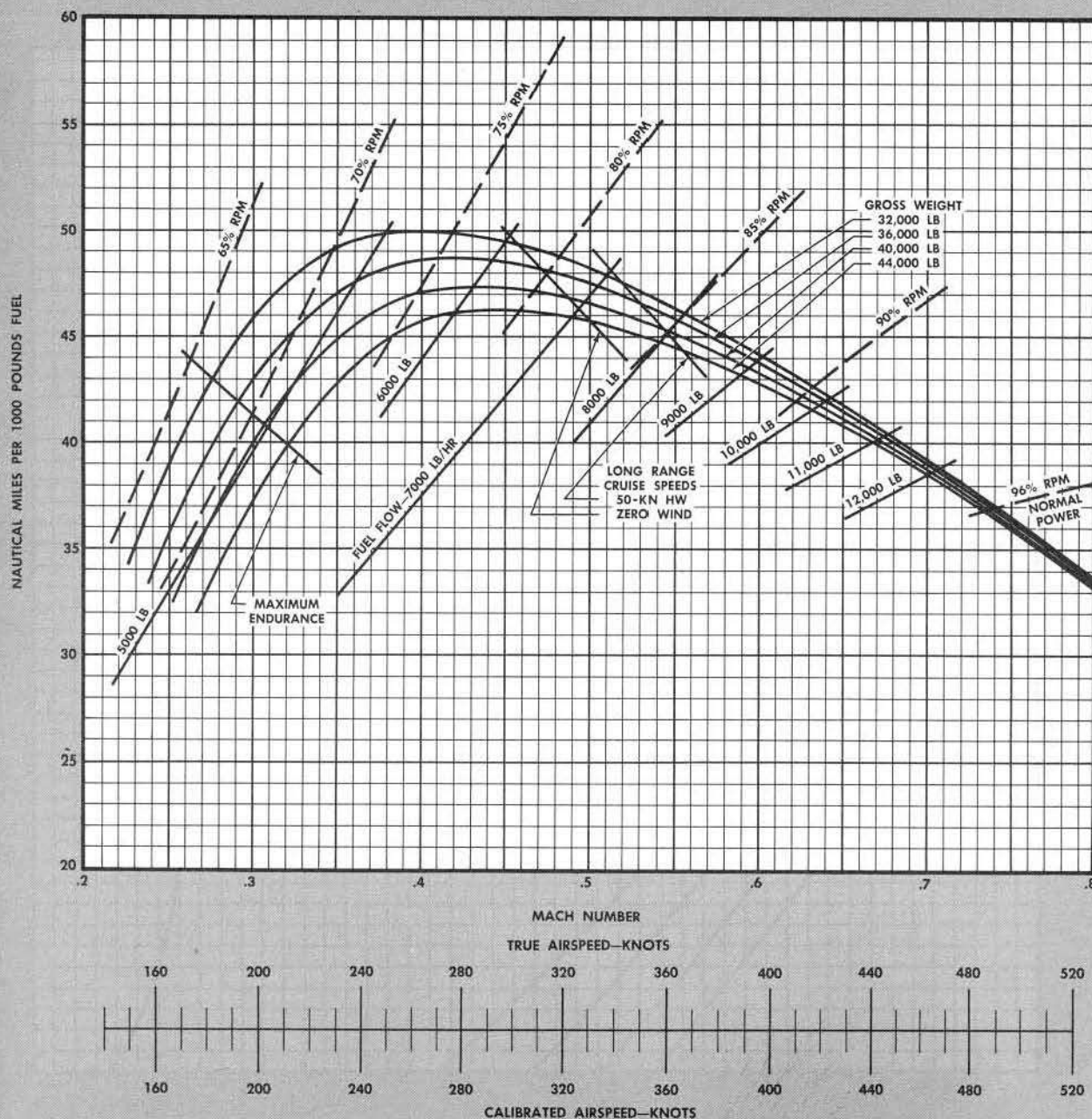
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-333

Figure A-10 (Sheet 1 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

5000 FEET
NO EXTERNAL LOAD

J35-35

OR

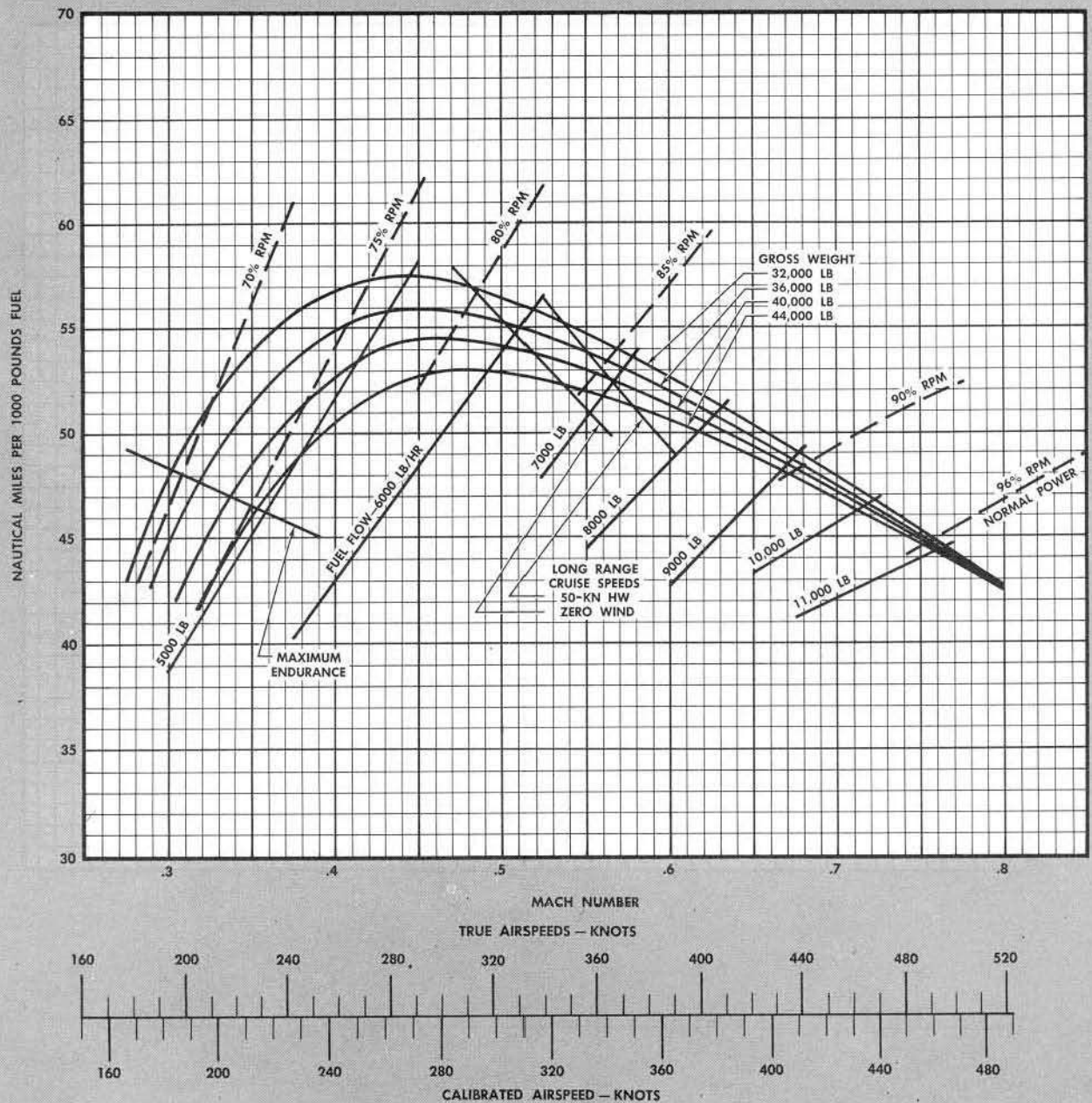
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-334

Figure A-10 (Sheet 2 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

10,000 FEET
NO EXTERNAL LOAD

J35-35

OR

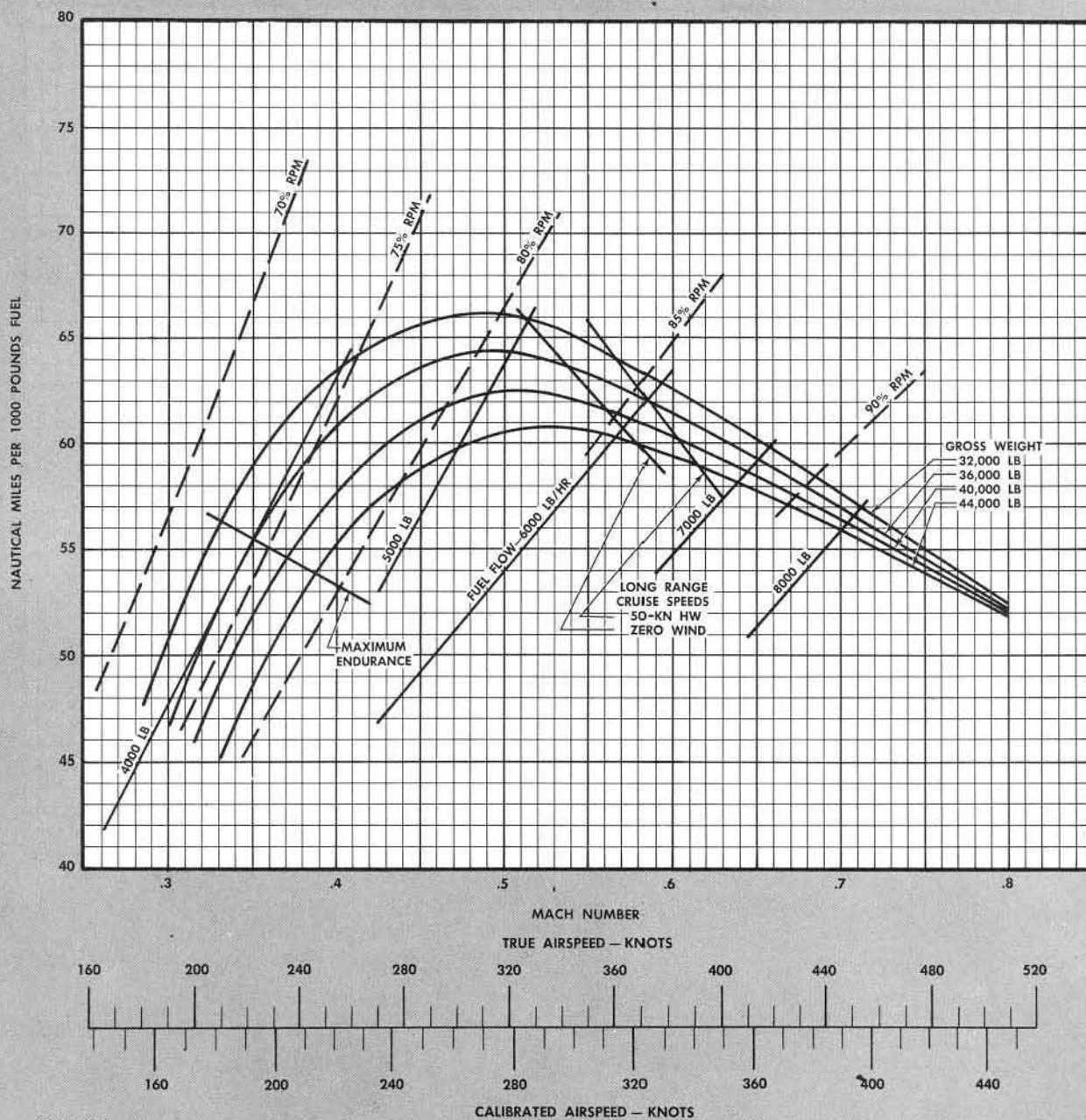
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-335

Figure A-10 (Sheet 3 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

15,000 FEET
NO EXTERNAL LOAD

J35-35

OR

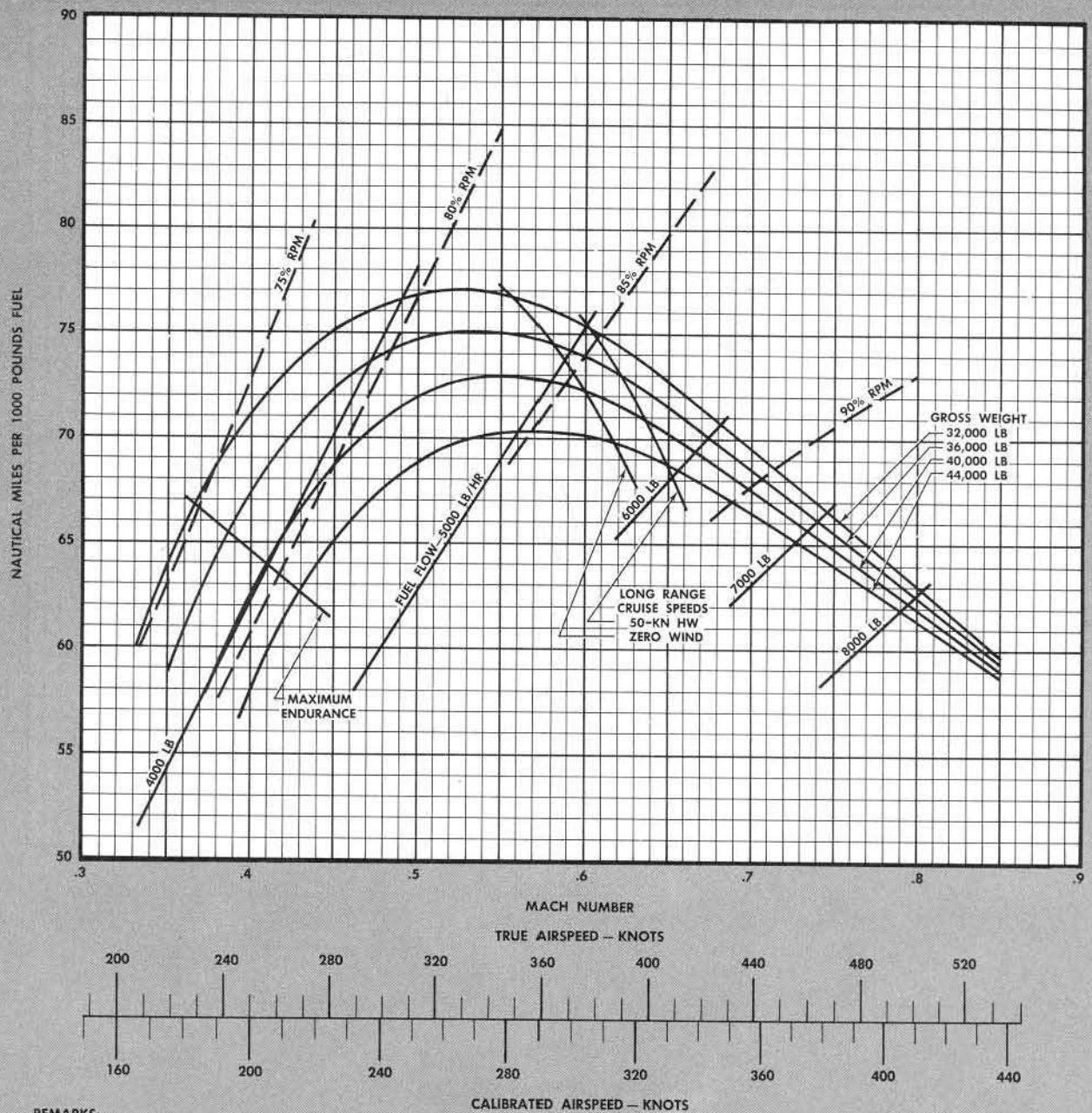
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-336

Figure A-10 (Sheet 4 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

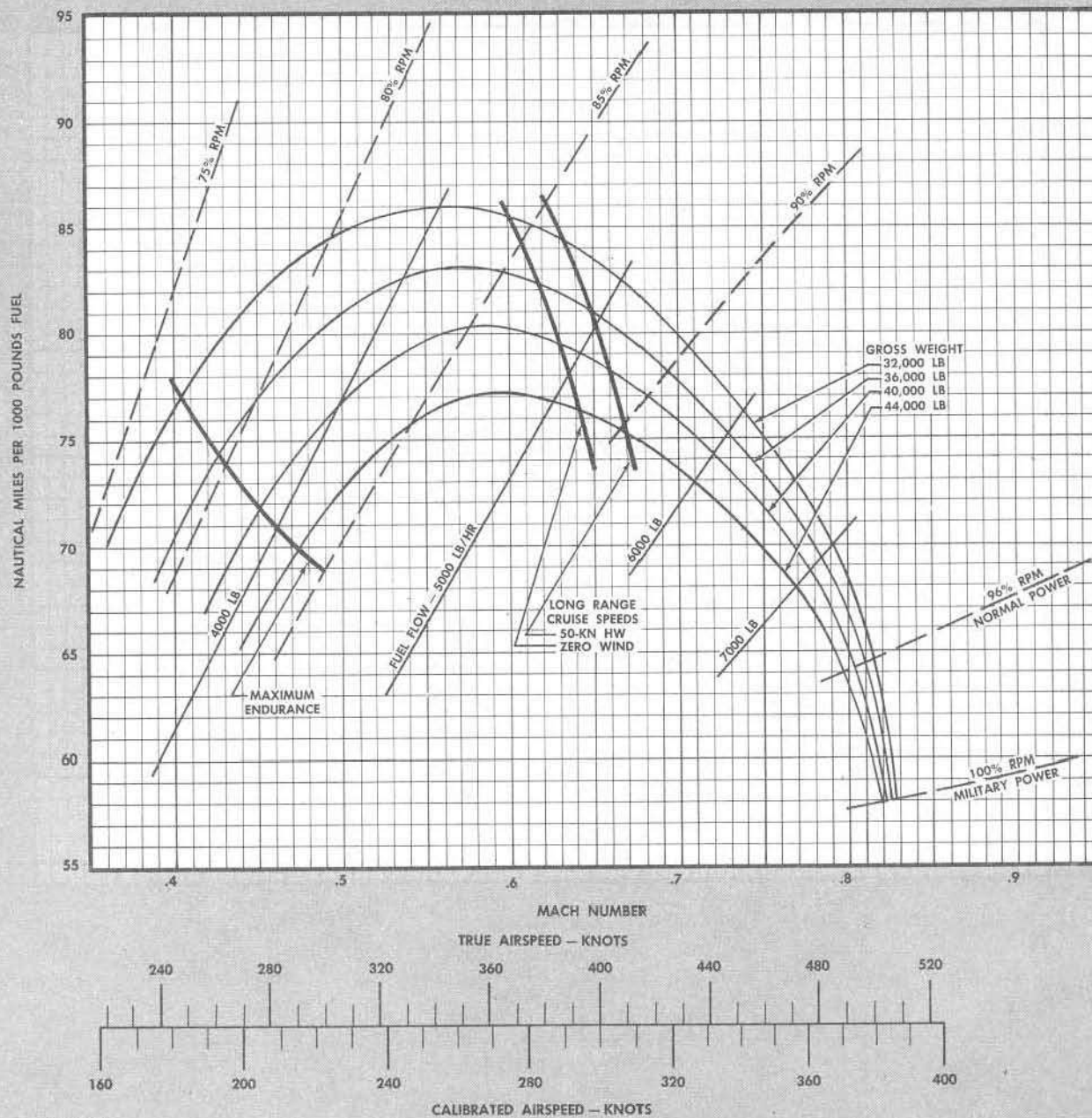
MODEL: F-89D

20,000 FEET
NO EXTERNAL LOAD

J35-35

OR

ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 57FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-337

Figure A-10 (Sheet 5 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

25,000 FEET
NO EXTERNAL LOAD

J35-35

OR

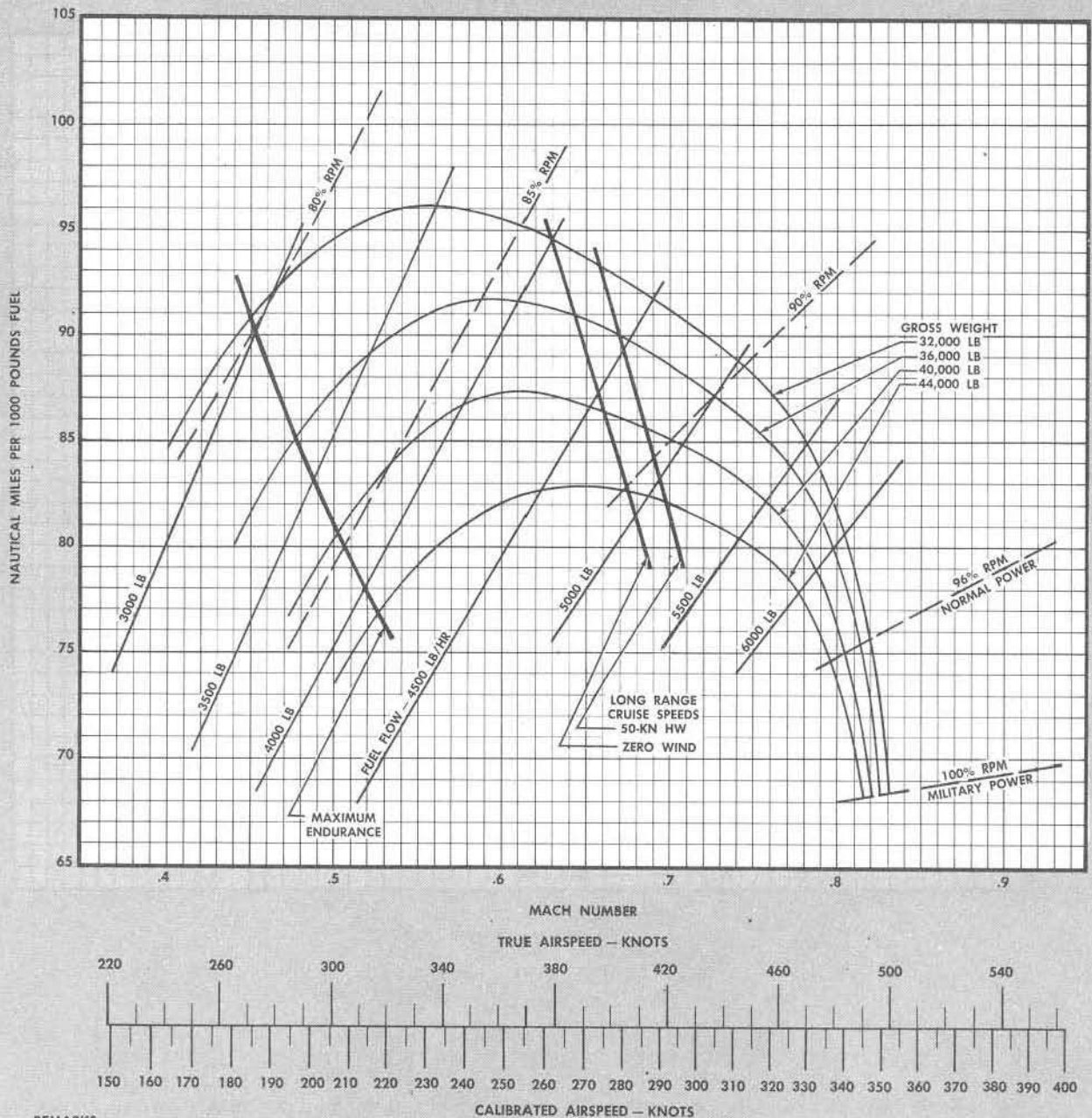
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 57

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-338

Figure A-10 (Sheet 6 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

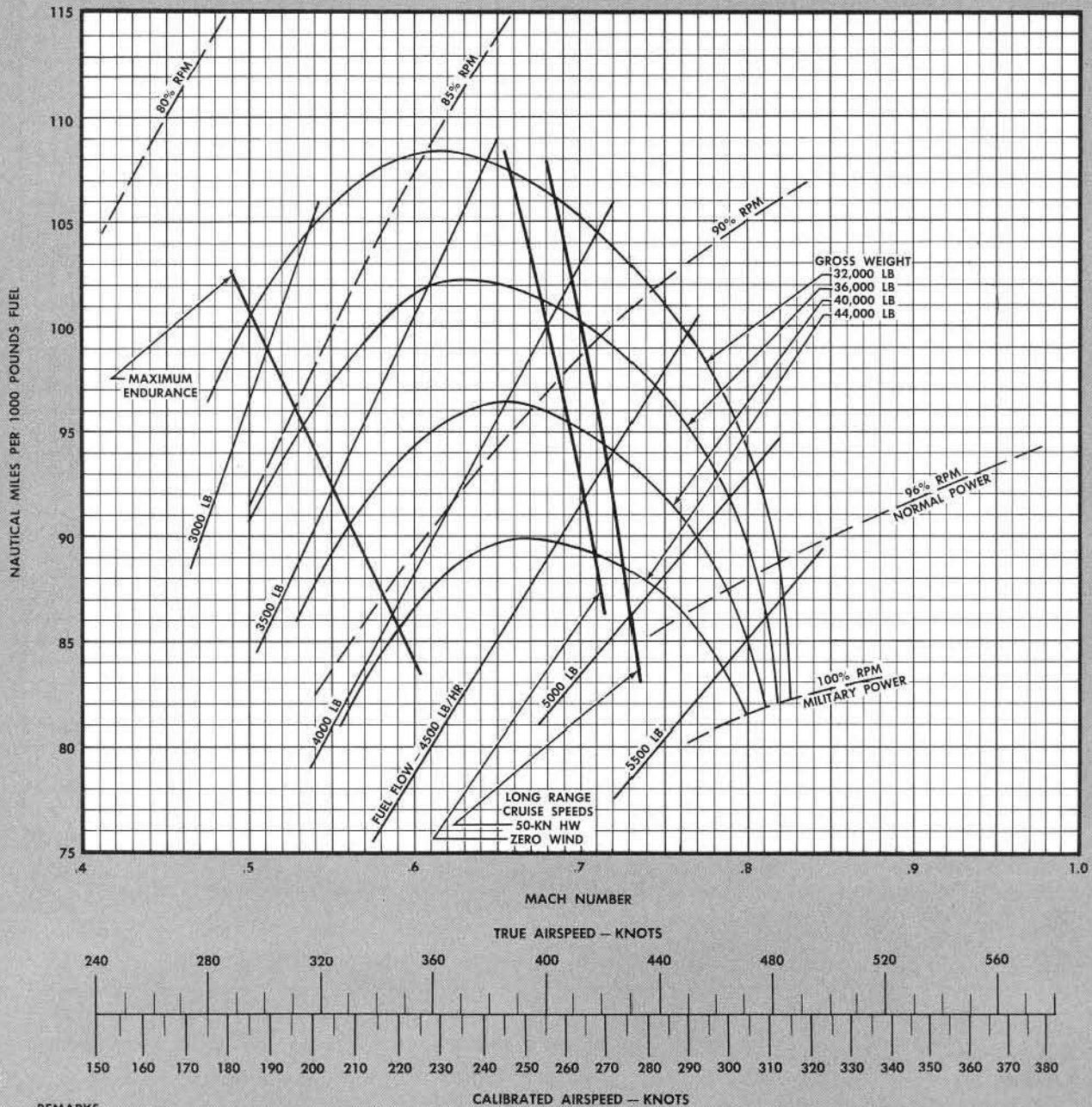
30,000 FEET
NO EXTERNAL LOADJ35-35
OR
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 57

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-339

Figure A-10 (Sheet 7 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

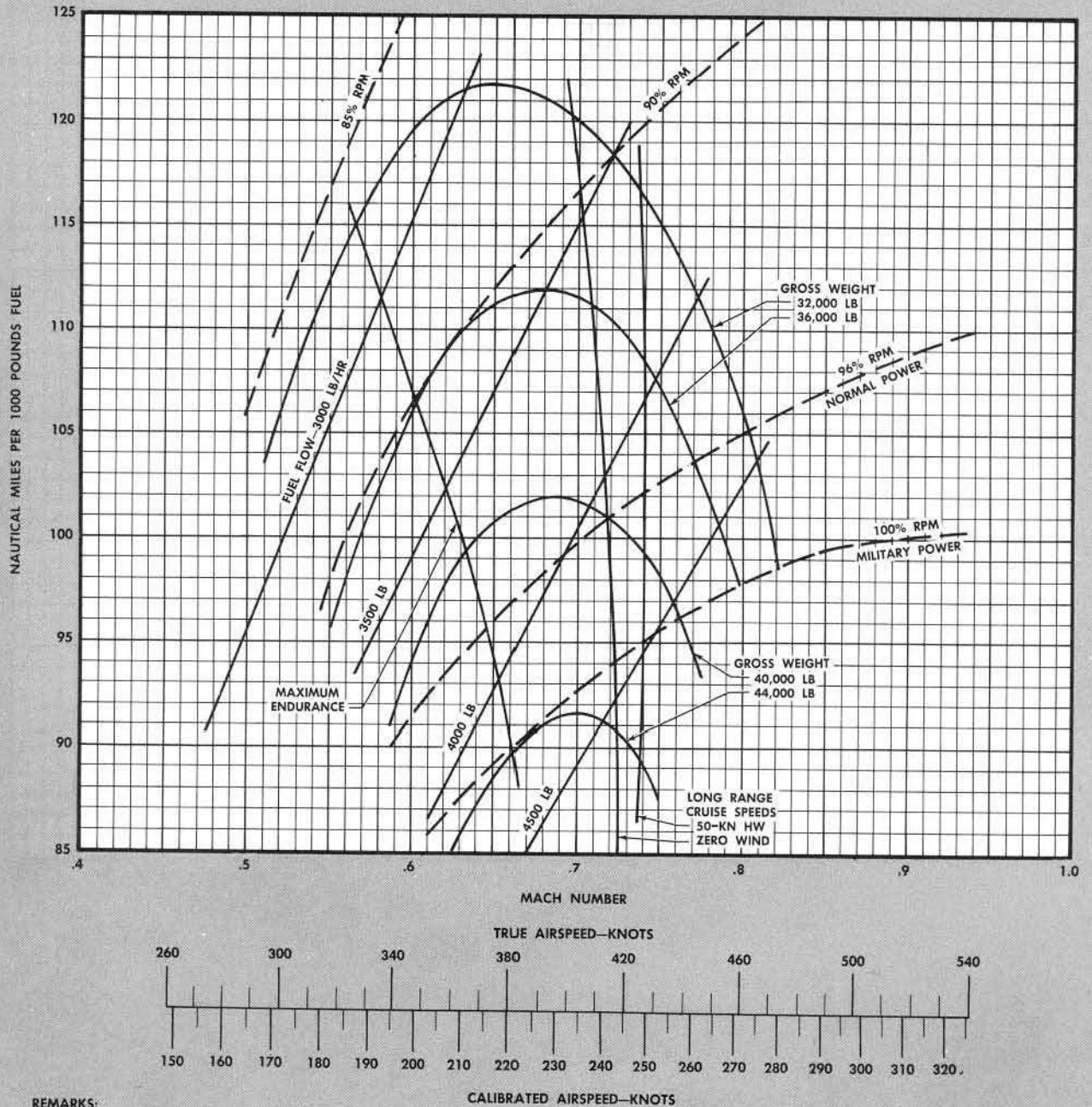
35,000 FEET
NO EXTERNAL LOADJ35-35
OR
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-340

Figure A-10 (Sheet 8 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

40,000 FEET
NO EXTERNAL LOADJ35-35
OR

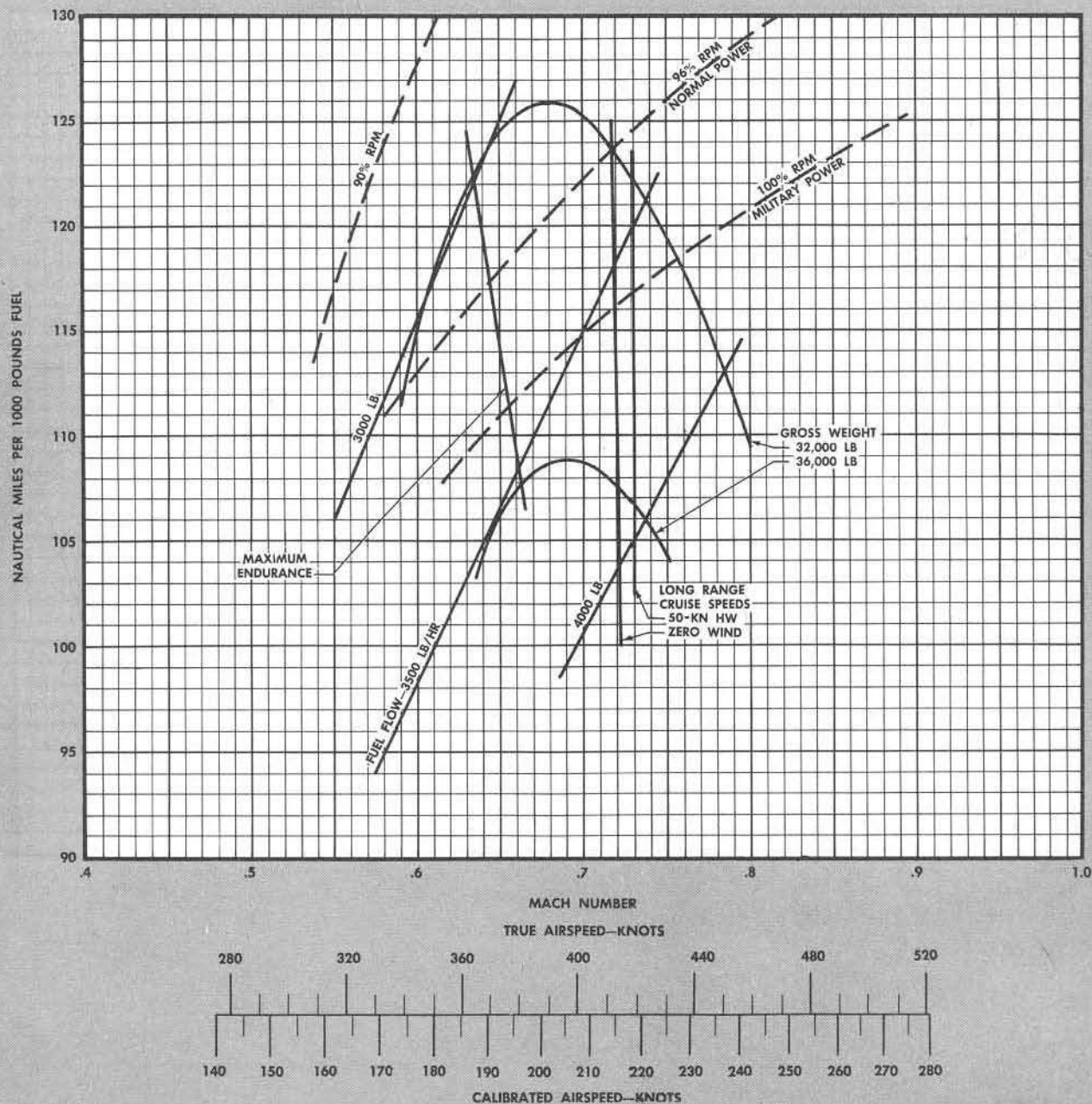
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-341

Figure A-10 (Sheet 9 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

ONE ENGINE OPERATING
SEA LEVEL
NO EXTERNAL LOAD

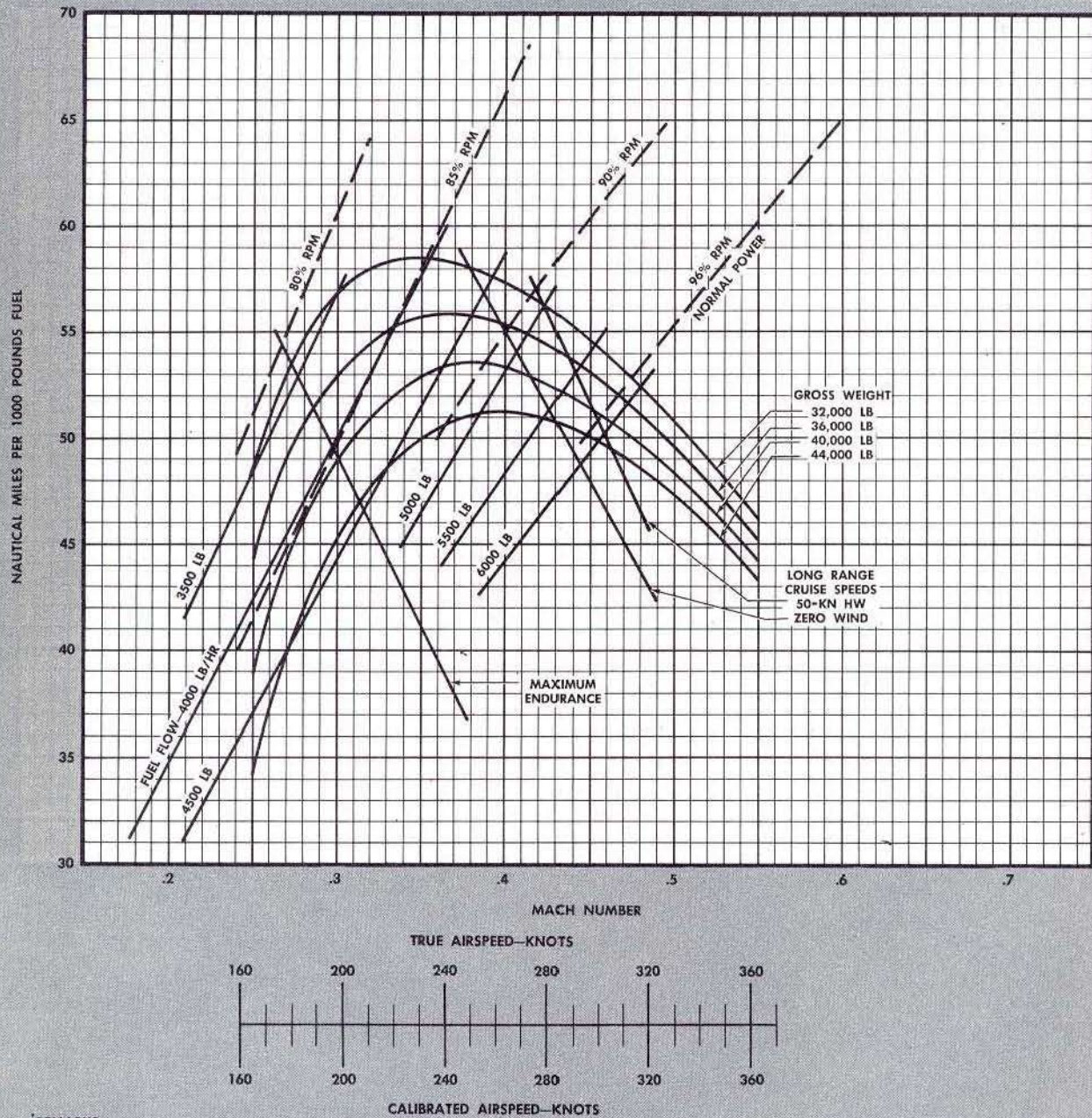
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-342

Figure A-10 (Sheet 10 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

ONE ENGINE OPERATING

5000 FEET

NO EXTERNAL LOAD

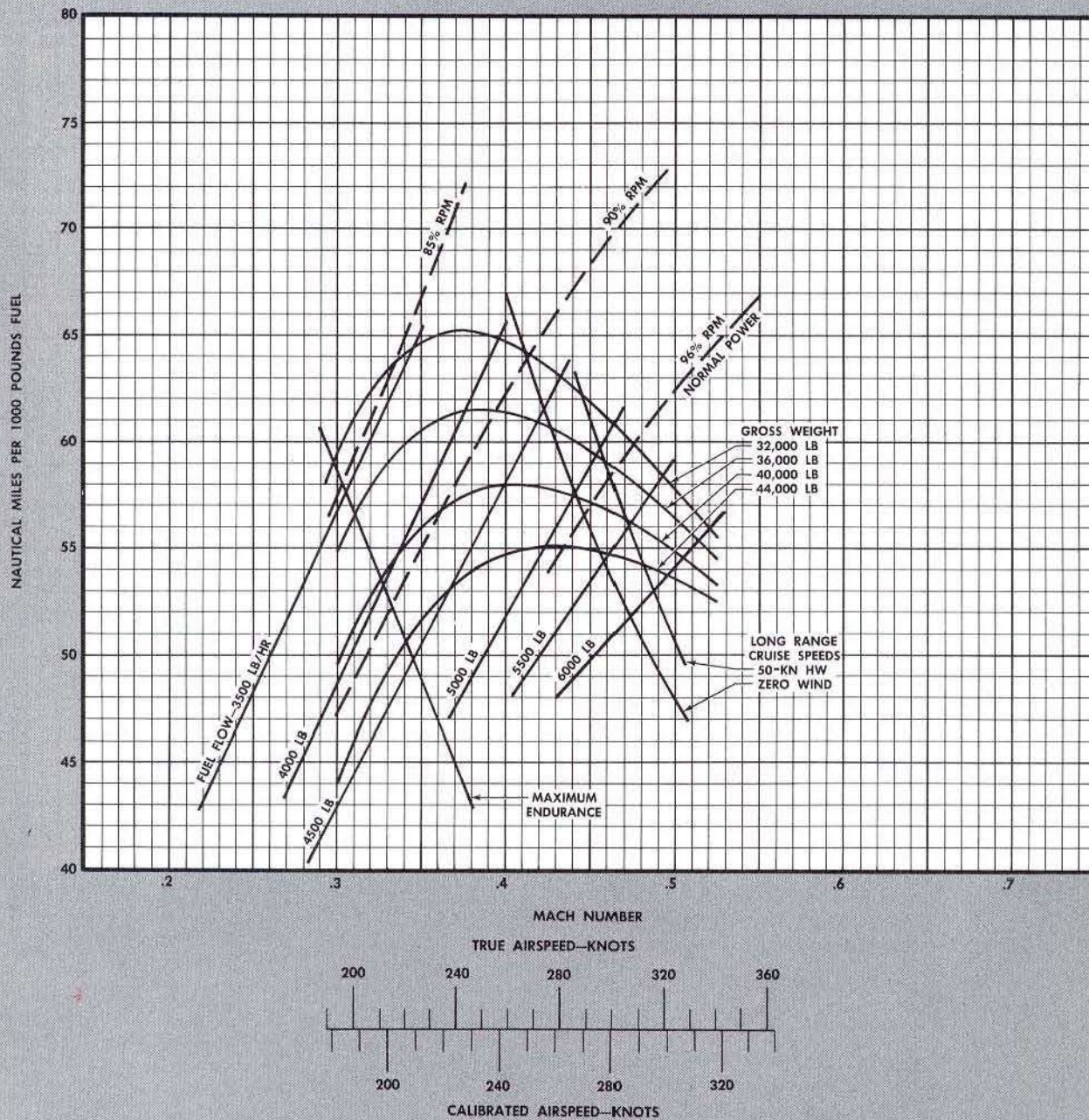
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-343

Figure A-10 (Sheet 11 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

ONE ENGINE OPERATING
10,000 FEET
NO EXTERNAL LOAD

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

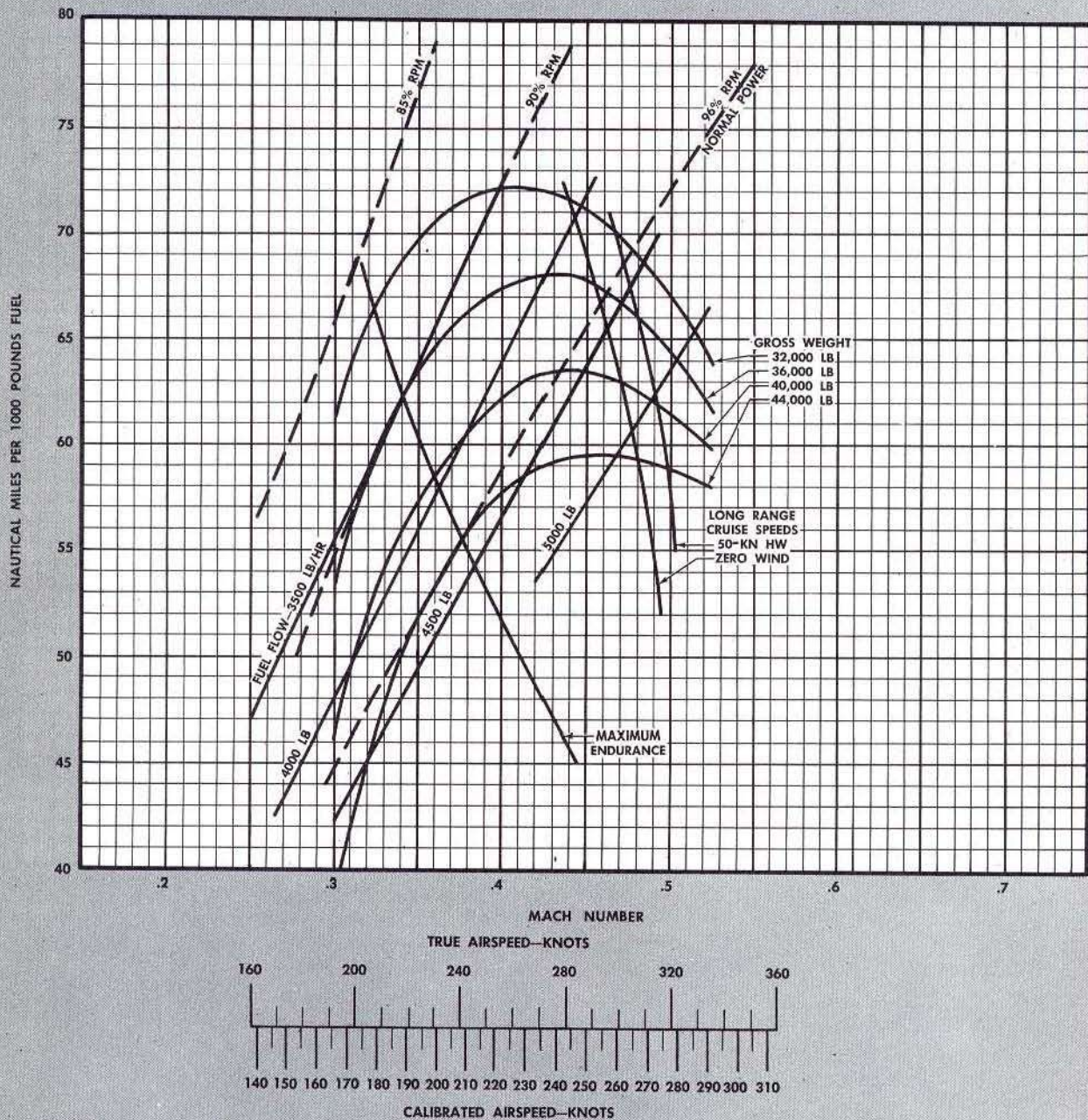
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

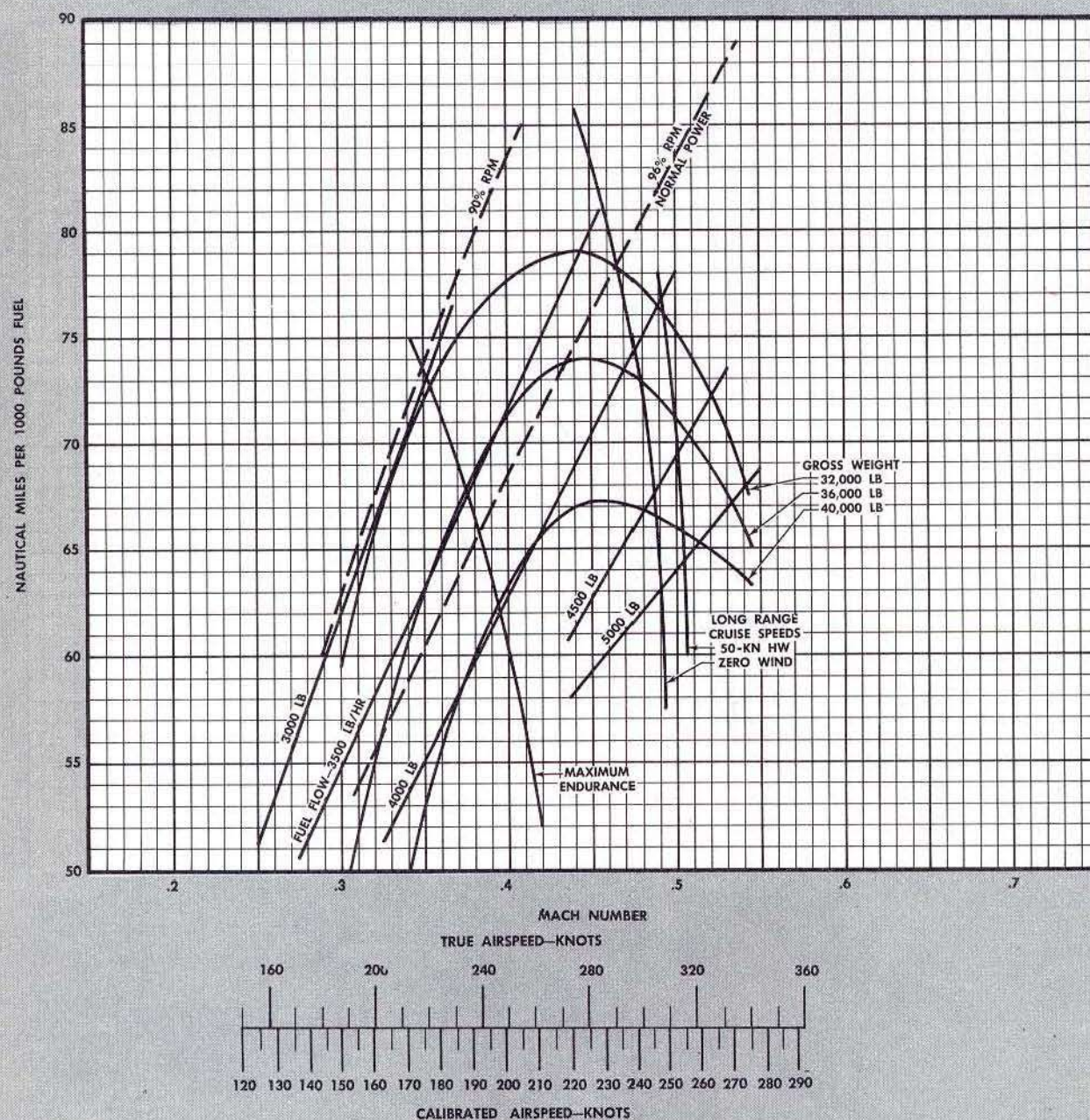
1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-344

Figure A-10 (Sheet 12 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56ONE ENGINE OPERATING
15,000 FEET
NO EXTERNAL LOADJ35-35
OR
ENGINE(S): (2) J35-47FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-345

Figure A-10 (Sheet 13 of 14 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

ONE ENGINE OPERATING
20,000 FEET
NO EXTERNAL LOAD

J35-35

OR

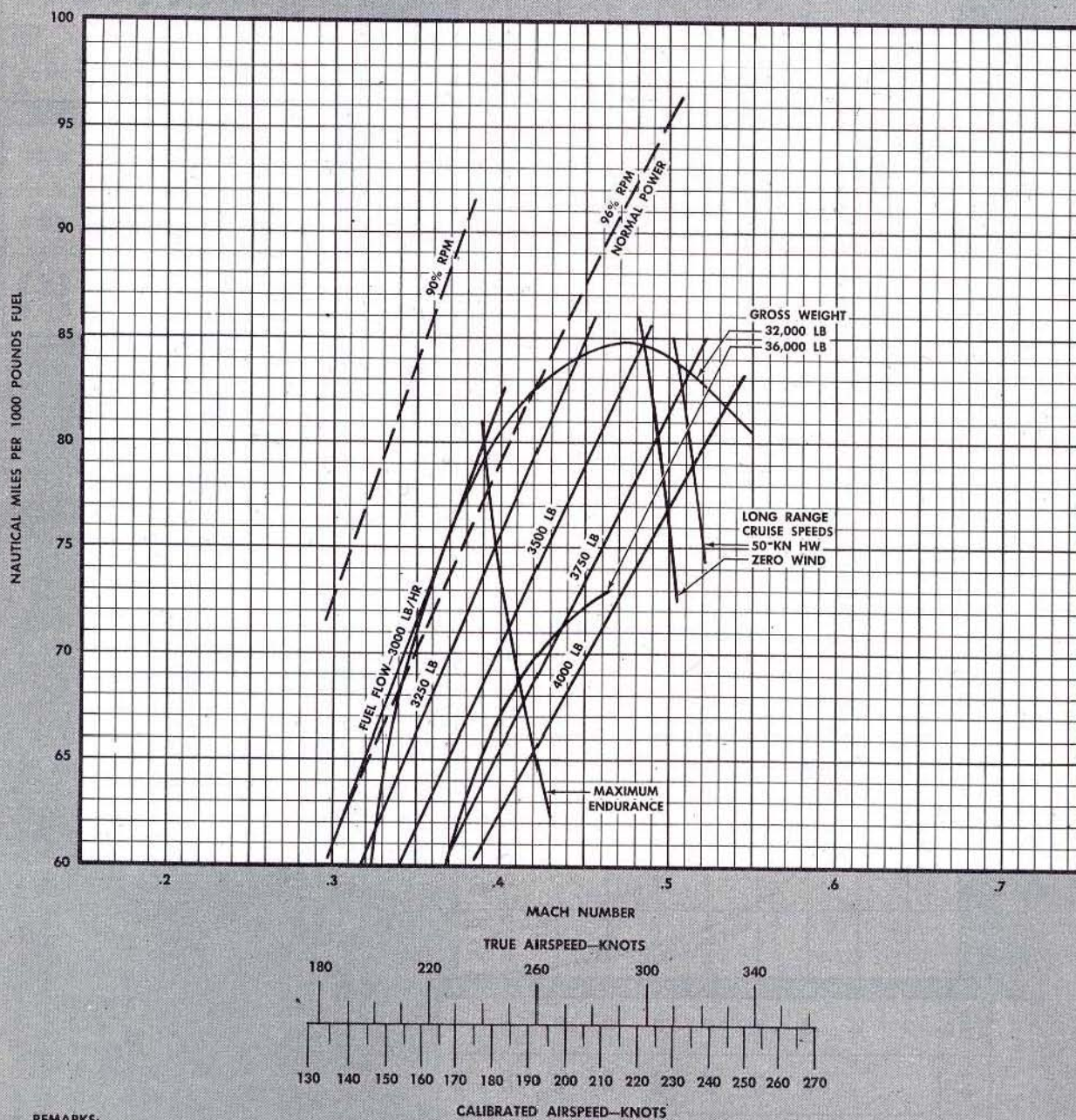
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-346

Figure A-10 (Sheet 14 of 14 Sheets).

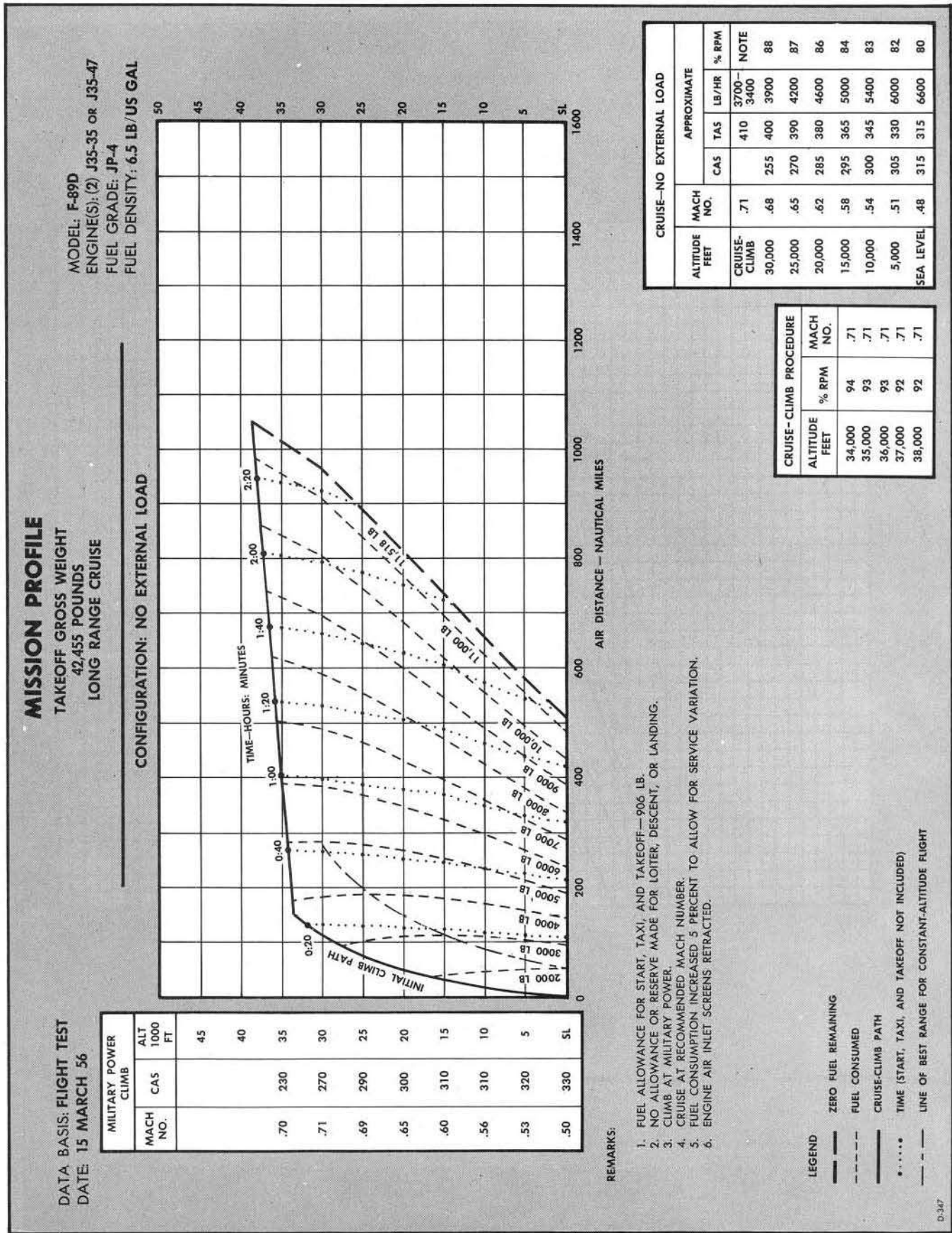


Figure A-11.

INTERCEPT PROFILE

TAKEOFF GROSS WEIGHT

42,455 POUNDS

MILITARY POWER CRUISE

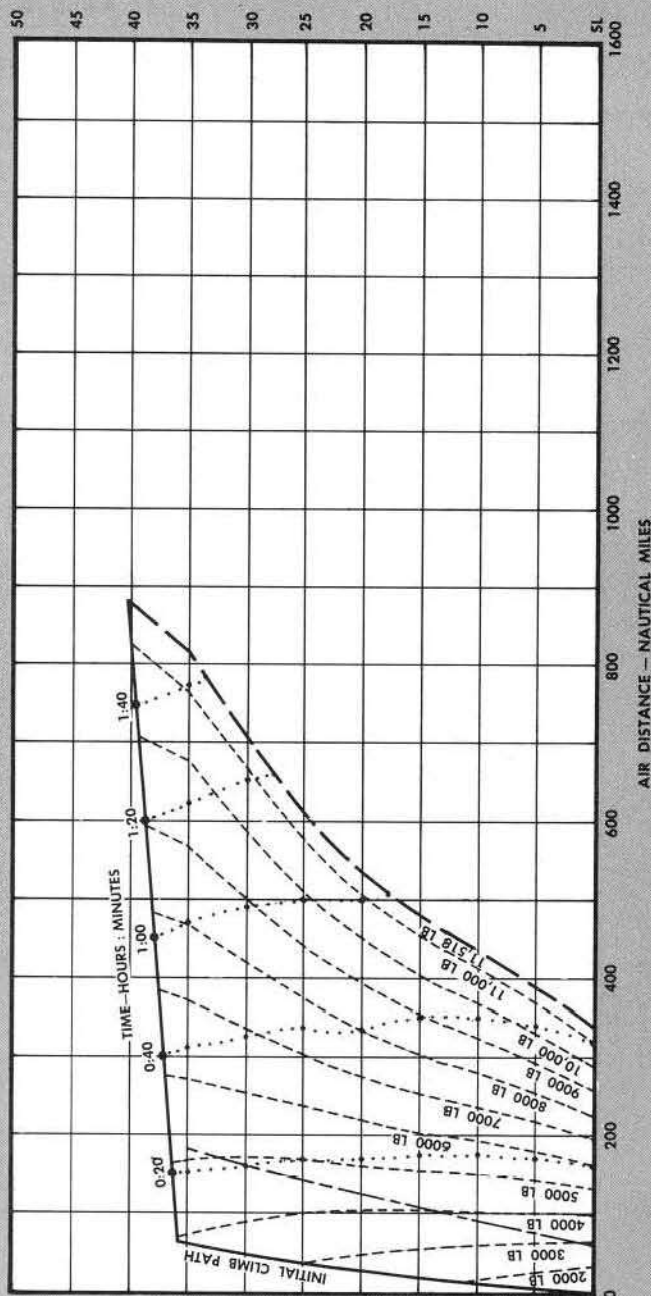
MODEL: F-89D

ENGINE(S):(2) J35-35 OR J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: NO EXTERNAL LOAD



MAXIMUM POWER CLIMB			
	MACH NO.	CAS	ALT 1000 FT
			45
			40
	.79	270	35
	.79	300	30
	.79	330	25
	.79	370	20
	.78	400	15
	.77	430	10
	.74	450	5
	.69	460	5L

REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF — 906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MAXIMUM POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
ENGINE AIR INLET SCREENS RETRACTED

LEGEND

- ZERO FUEL REMAINING
- FUEL CONSUMED
- CRUISE-CLIMB PATH
- TIME (START, TAXI, AND
- LINE OF BEST RANGE FOR

CRUISE — NO EXTERNAL LOAD					
ALTITUDE FEET	MACH NO.	APPROXIMATE			% RPM
		CAS	TAS	LB/HR	
CRUISE- CLIMB	.77		440	4,400— 3,700	100
35,000	.80	270	460	4,700	100
30,000	.82	315	485	5,000	100
25,000	.83	350	495	5,300	100
20,000	.83	385	505	5,700	100
15,000	.83	425	515	10,300	100
10,000	.82	460	525	11,800	100
5,000	.78	475	510	13,300	100
SEA LEVEL	.72	475	475	15,000	100

CRUISE-CLIMB PROCEDURE	MACH NO.	
	ALTITUDE FEET	% RPM
	36,000	100
	37,000	100
	38,000	100
	39,000	100
	40,000	100

Figure A-12.

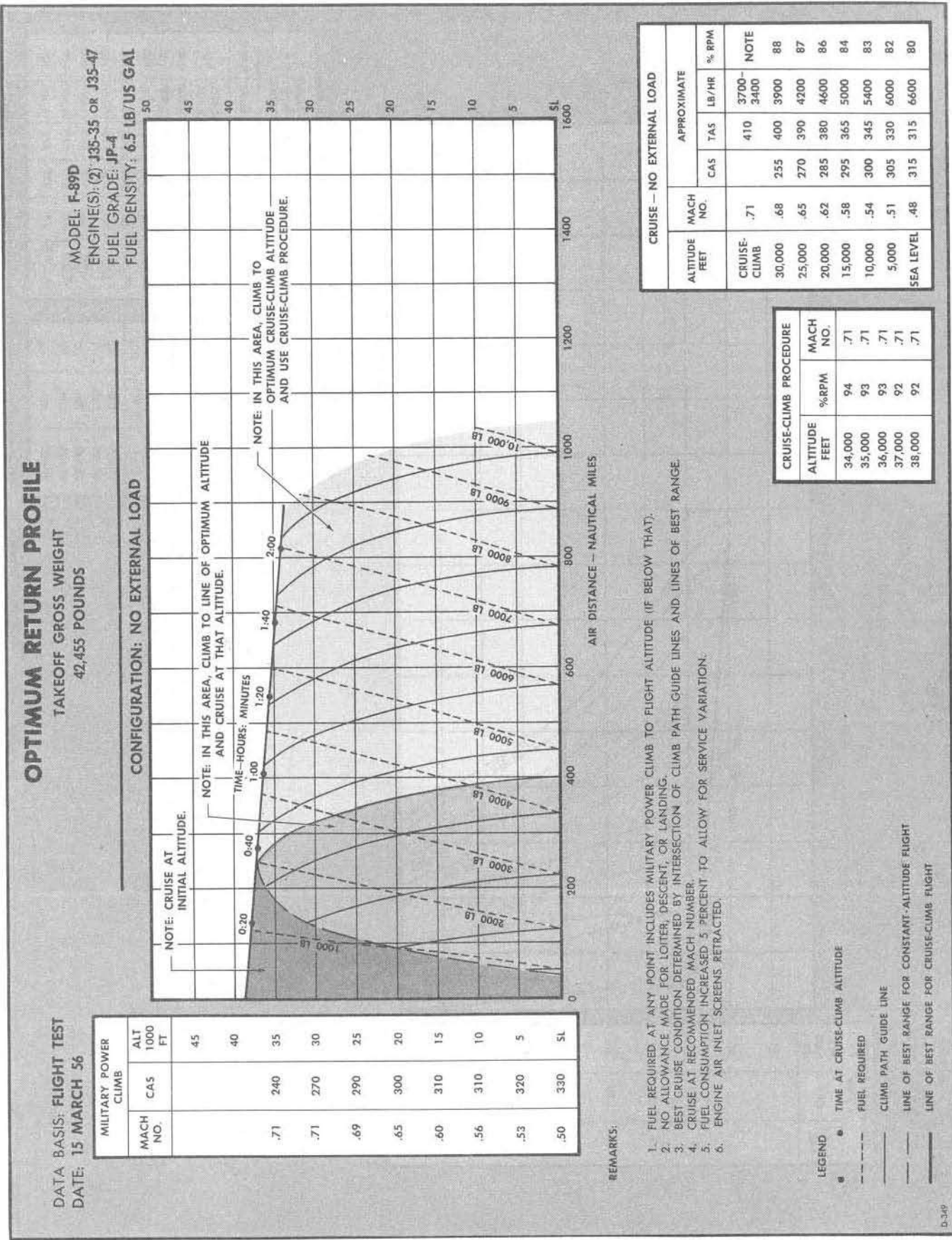


Figure A-13 (Sheet 1 of 2 Sheets).

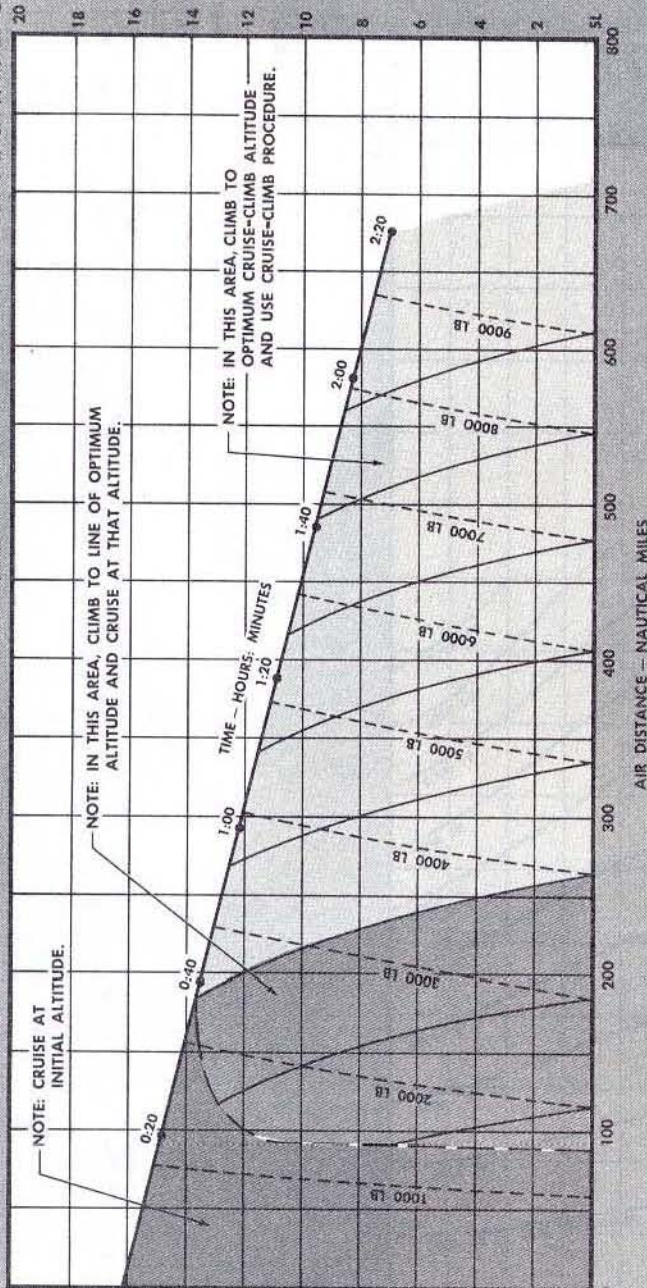
OPTIMUM RETURN PROFILE

TAKEOFF GROSS WEIGHT
42,455 POUNDS
ONE ENGINE OPERATING

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56

MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: NO EXTERNAL LOAD



REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO FLIGHT ALTITUDE (IF BELOW THAT).
2. NO ALLOWANCE MADE FOR LOITER, DESCENT, OR LANDING.
3. BEST CRUISE CONDITION DETERMINED BY INTERSECTION OF CLIMB PATH GUIDE LINES AND LINES OF BEST RANGE.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

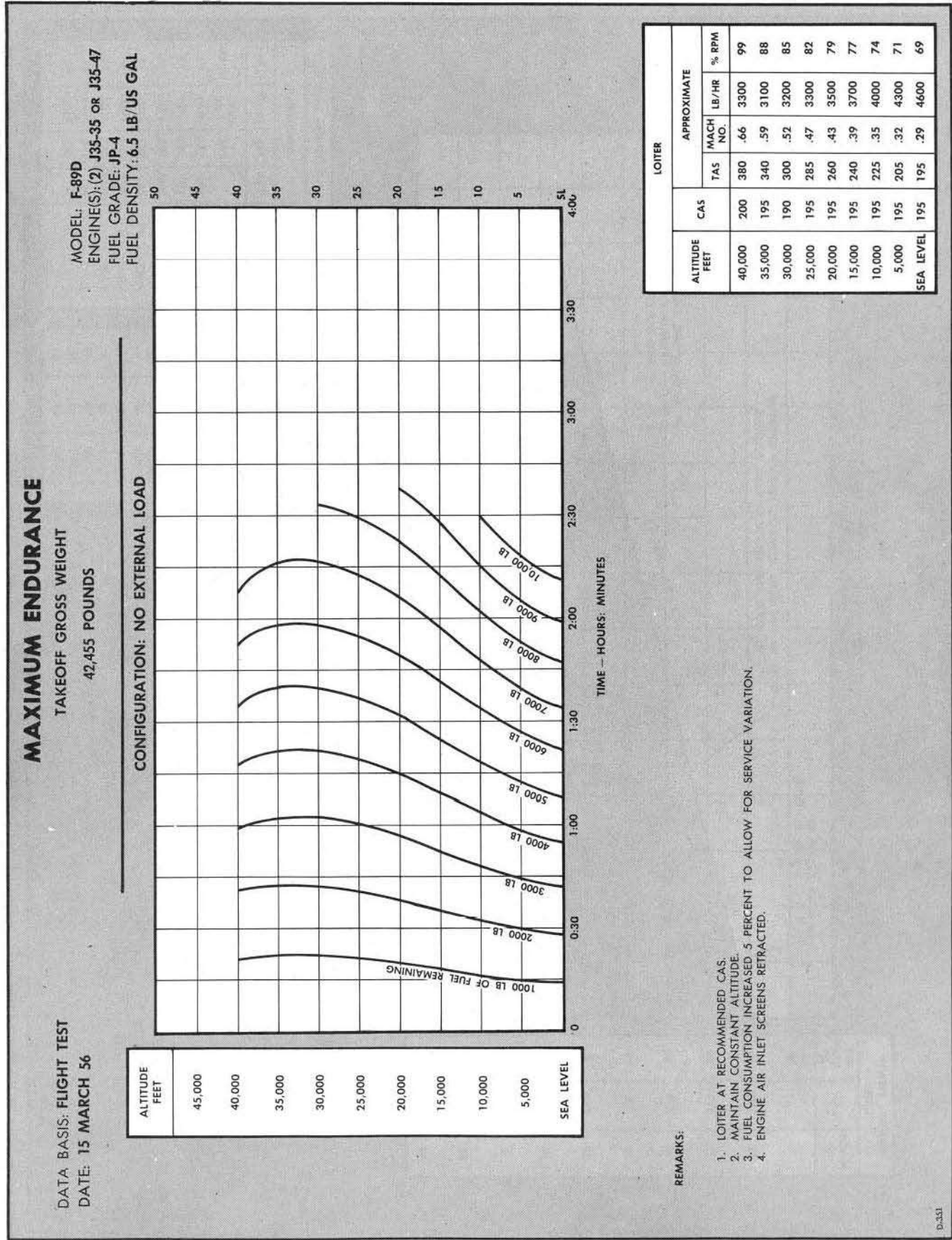
LEGEND

- TIME AT CRUISE-CLIMB ALTITUDE
- FUEL REQUIRED
- CLIMB PATH GUIDE LINE
- LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT
- LINE OF BEST RANGE FOR CRUISE-CLIMB FLIGHT

CRUISE - NO EXTERNAL LOAD				
ALTITUDE FEET	MACH NO.	APPROXIMATE		
		CAS	TAS	LB/HR
CRUISE- CLIMB	NOTE			4400 -
14,000	.46	235	290	3500
12,000	.46	250	290	3700
10,000	.45	250	285	3900
8,000	.44	260	285	4100
6,000	.43	260	280	4300
4,000	.42	260	275	4500
2,000	.41	265	270	4900
SEA LEVEL	.40	265	265	5800
				NOTE
				95
				95
				94
				94
				93
				92
				91
				90

CRUISE - CLIMB PROCEDURE		
ALTITUDE FEET	% RPM	MACH NO.
7,000	94	.44
8,000	94	.44
9,000	94	.45
10,000	94	.45
11,000	95	.45
12,000	95	.46
13,000	95	.46
14,000	95	.46
15,000	95	.46
16,000	95	.47

Figure A-13 (Sheet 2 of 2 Sheets).



MAXIMUM ENDURANCE

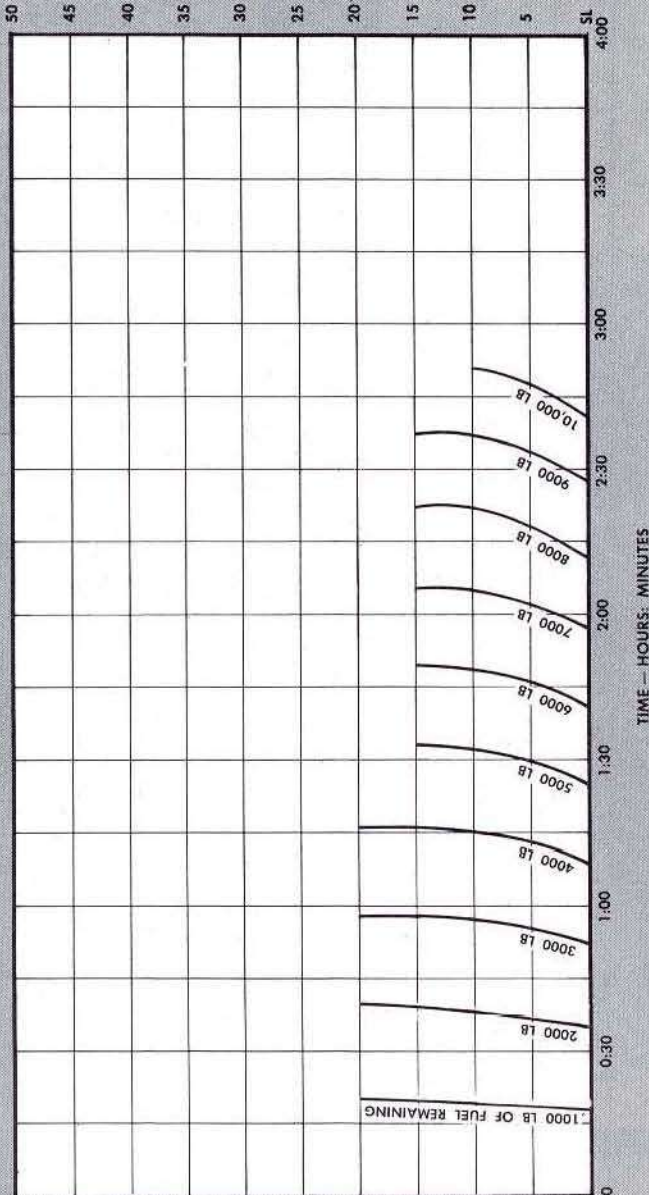
DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56

TAKEOFF GROSS WEIGHT
42,455 POUNDS
ONE ENGINE OPERATING

MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: NO EXTERNAL LOAD

ALTITUDE FEET
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
SEA LEVEL

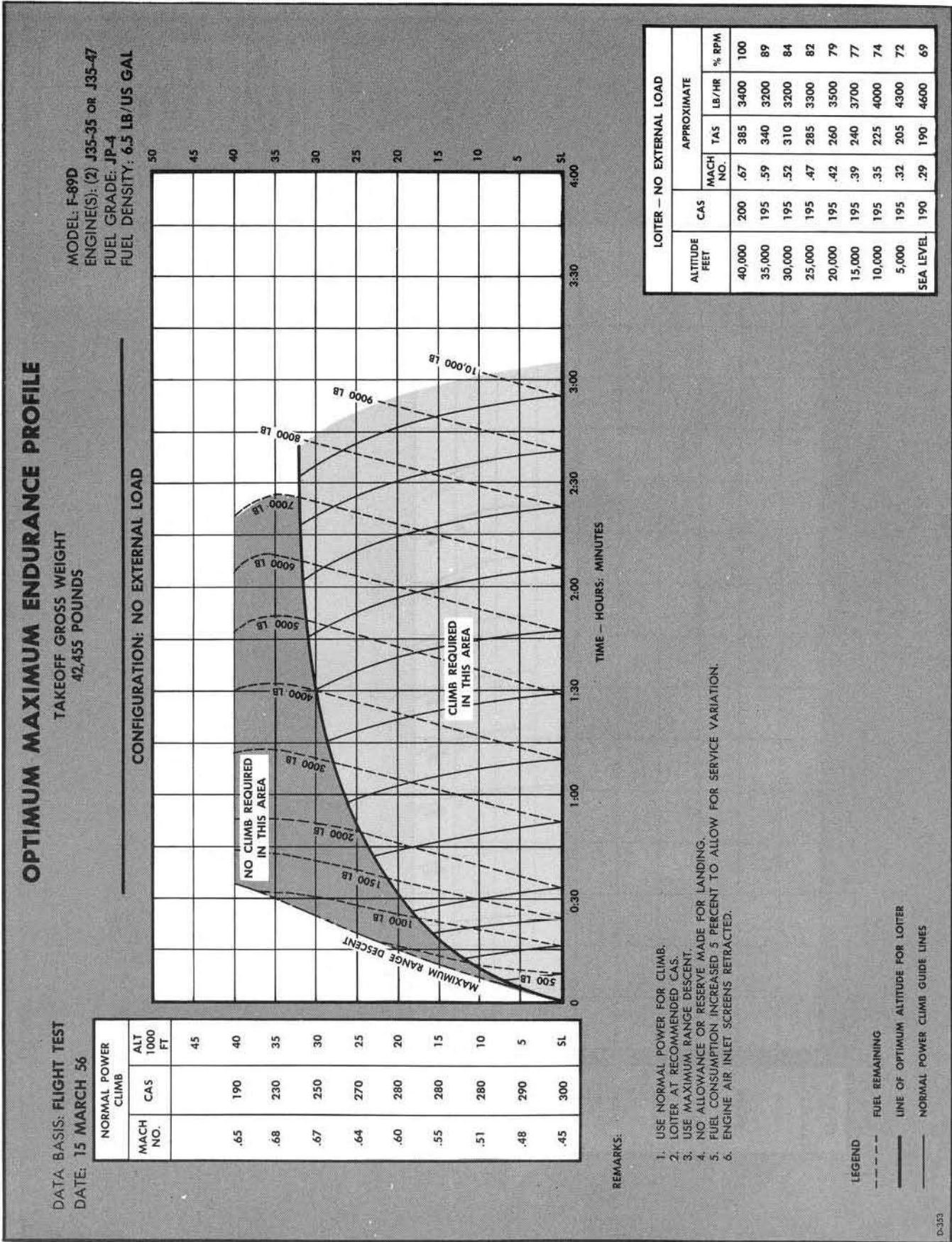


ALTITUDE FEET	LOITER		
	CAS	TAS	APPROXIMATE MACH NO. LB/HR % RPM
20,000	180	245	.40 3200 96
15,000	185	235	.37 3400 94
10,000	190	215	.34 3500 90
5,000	190	200	.31 3600 86
SEA LEVEL	190	190	.29 3800 83

REMARKS:

1. LOITER AT RECOMMENDED CAS.
2. MAINTAIN CONSTANT ALTITUDE.
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.

Figure A-14 (Sheet 2 of 2 Sheets).



BEST CLIMB PERFORMANCE

MODEL: F-89D

MAXIMUM POWER
WITH PYLON TANKS

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

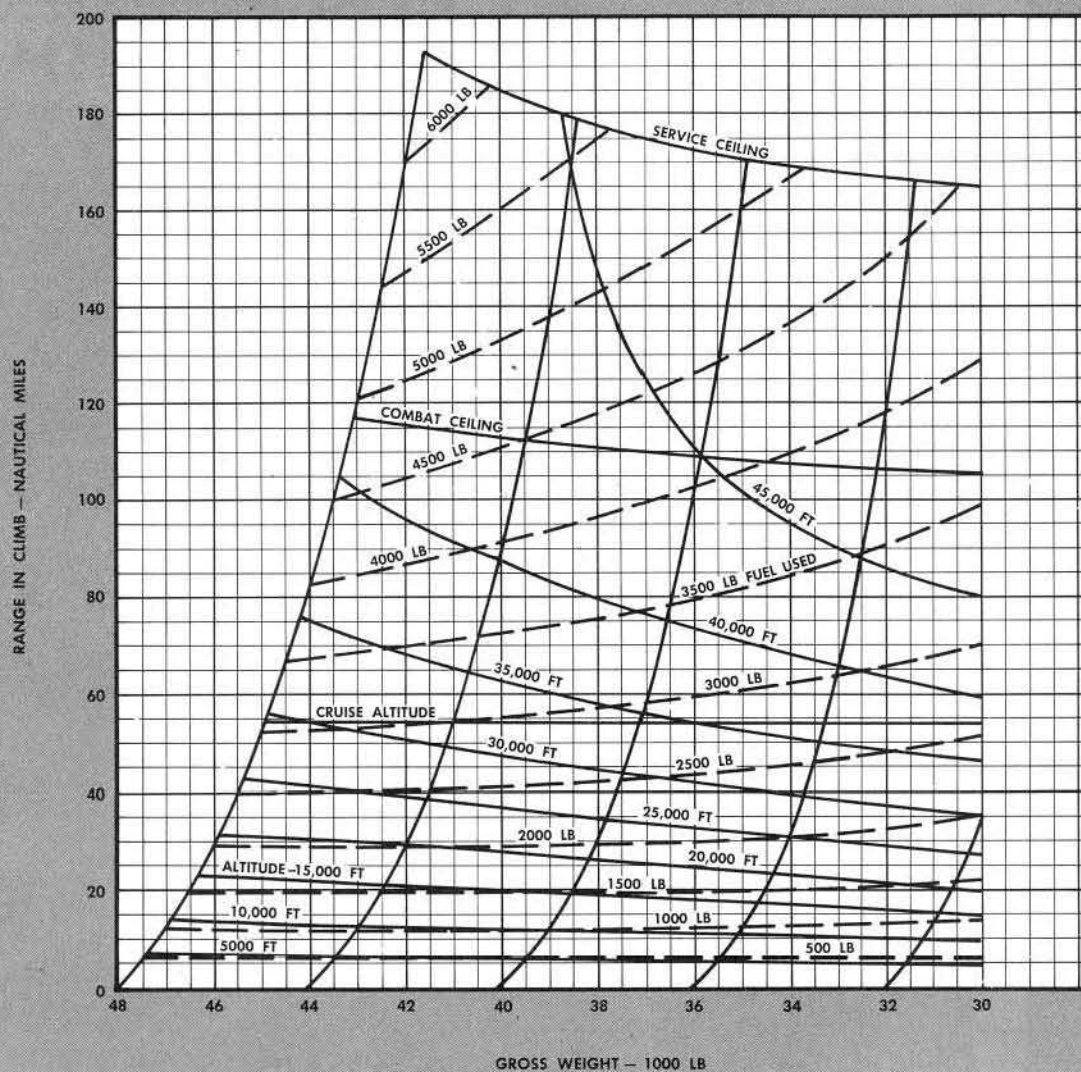
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-355

Figure A-16 (Sheet 1 of 9 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

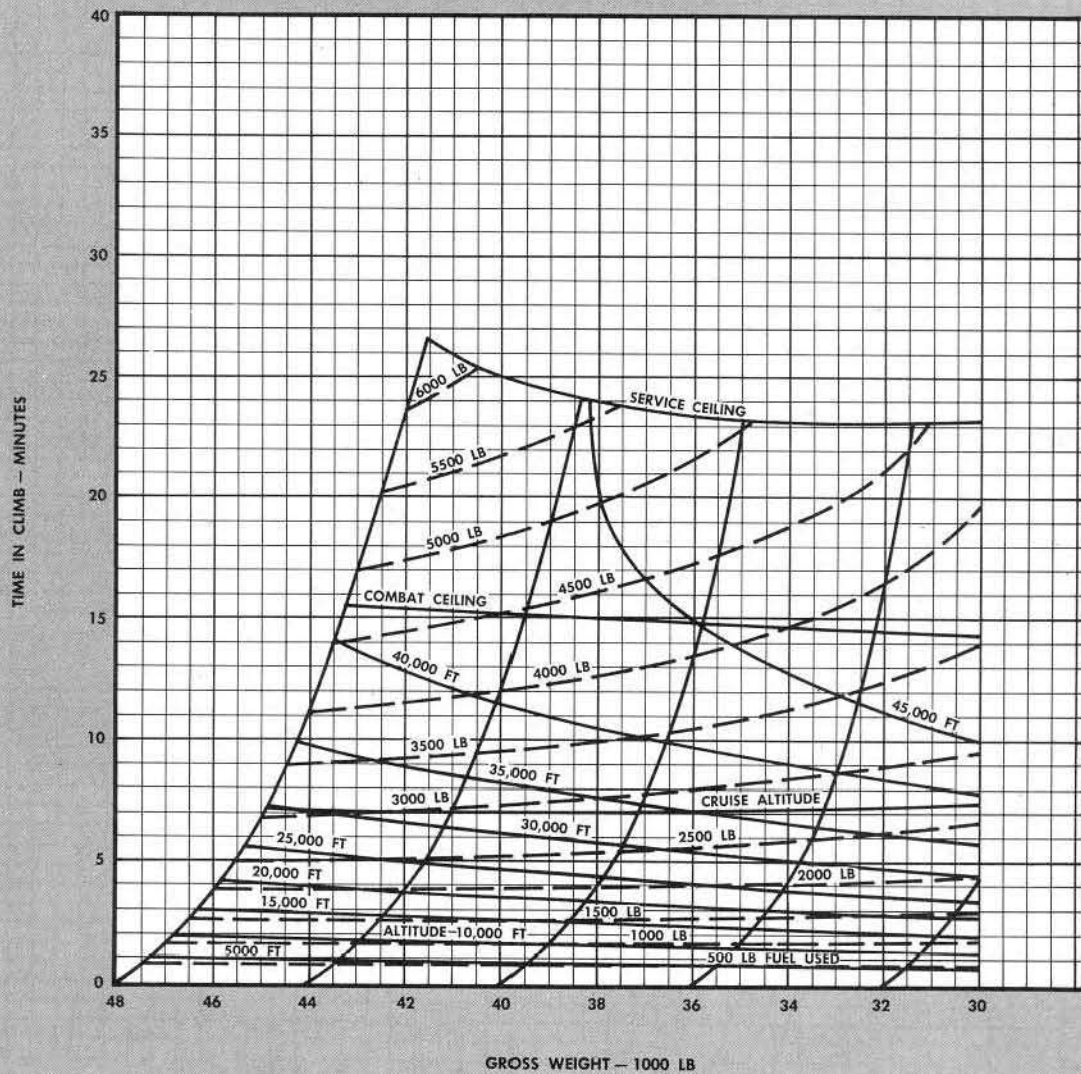
DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

MAXIMUM POWER
WITH PYLON TANKSJ35-35
OR
ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

Figure A-16 (Sheet 2 of 9 Sheets).

D-356

BEST CLIMB SPEED

MODEL: F-89D

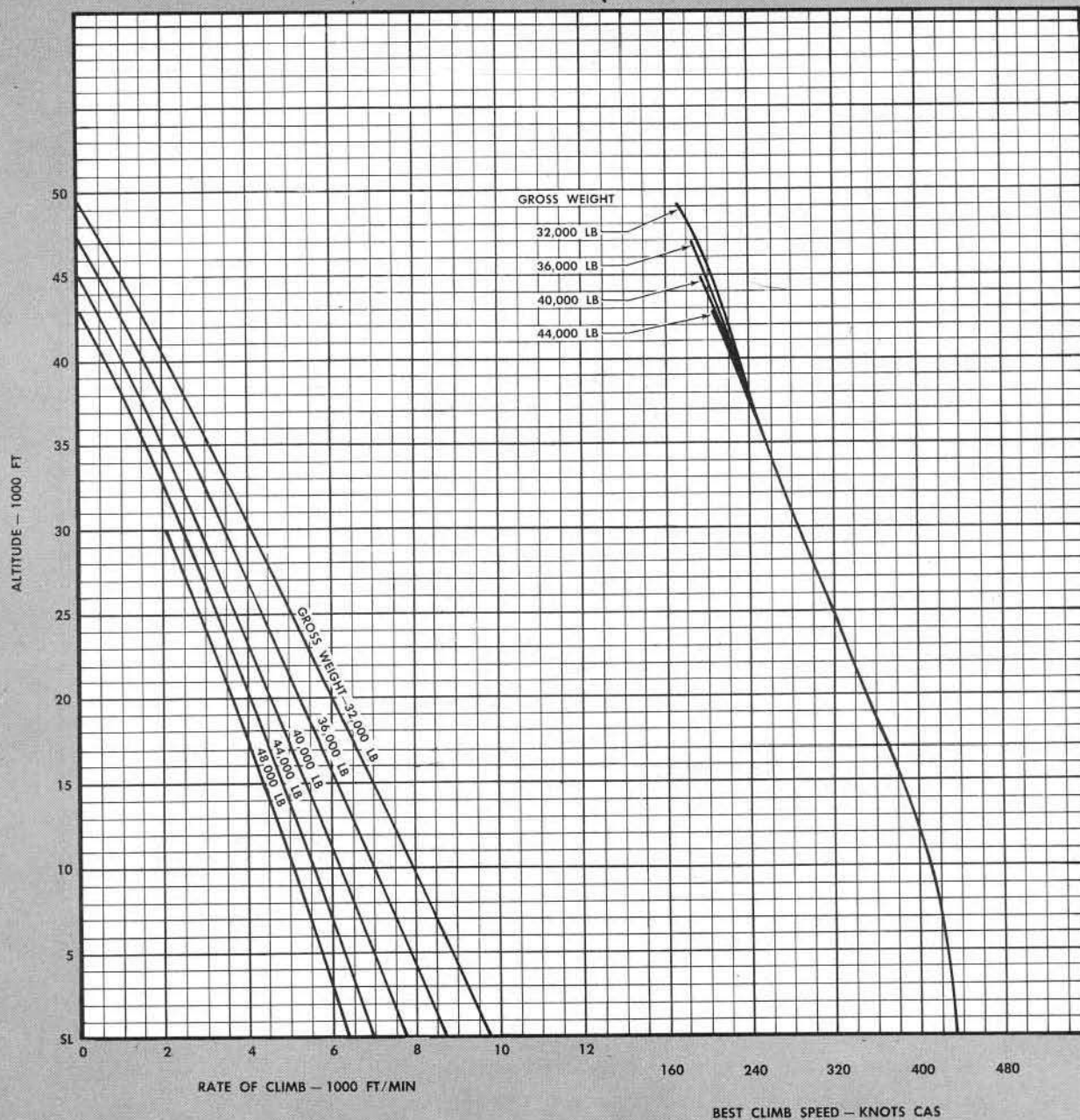
DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

MAXIMUM POWER
WITH PYLON TANKSJ35-35
OR
ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

D-357

Figure A-16 (Sheet 3 of 9 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

MILITARY POWER
WITH PYLON TANKS

J35-35

OR

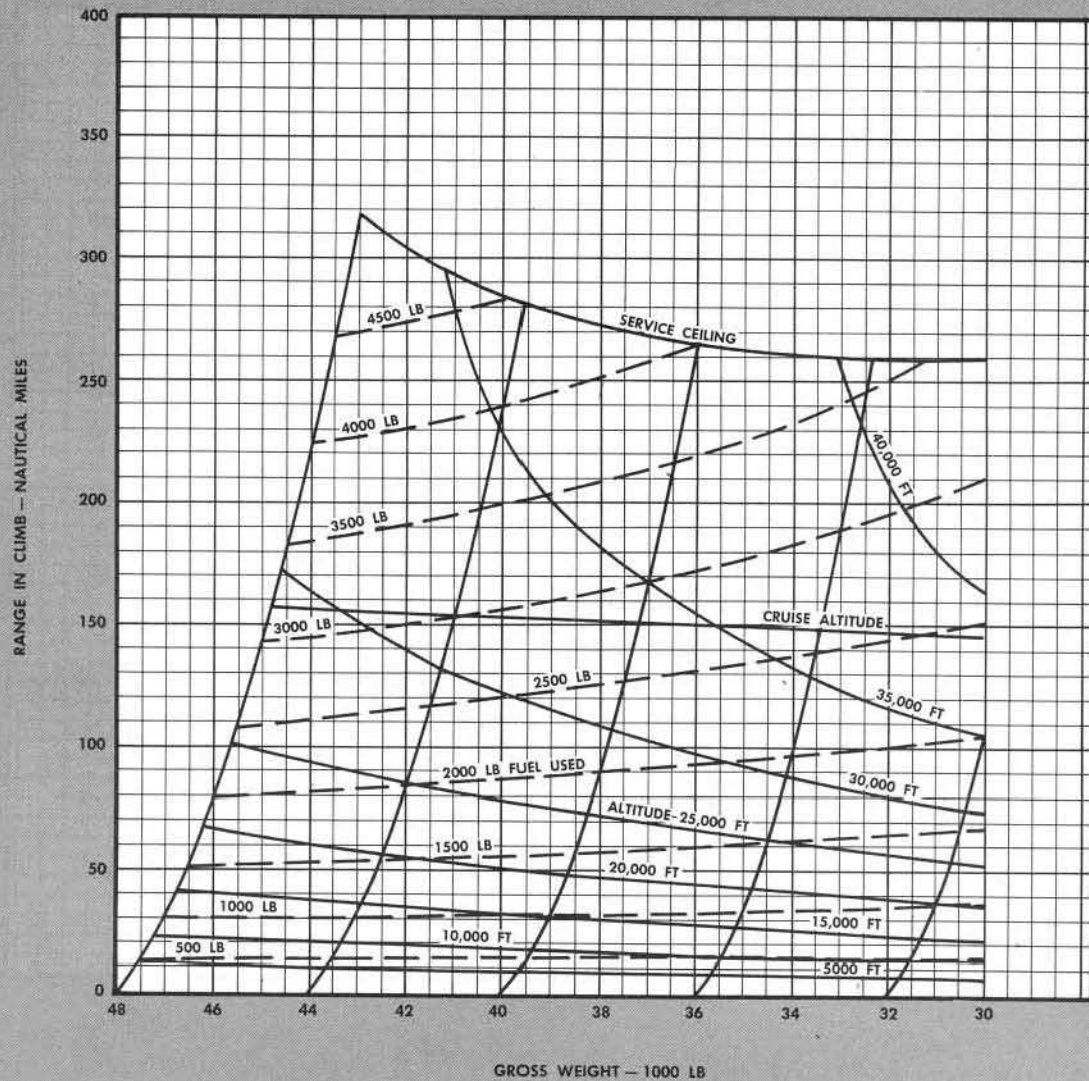
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-358

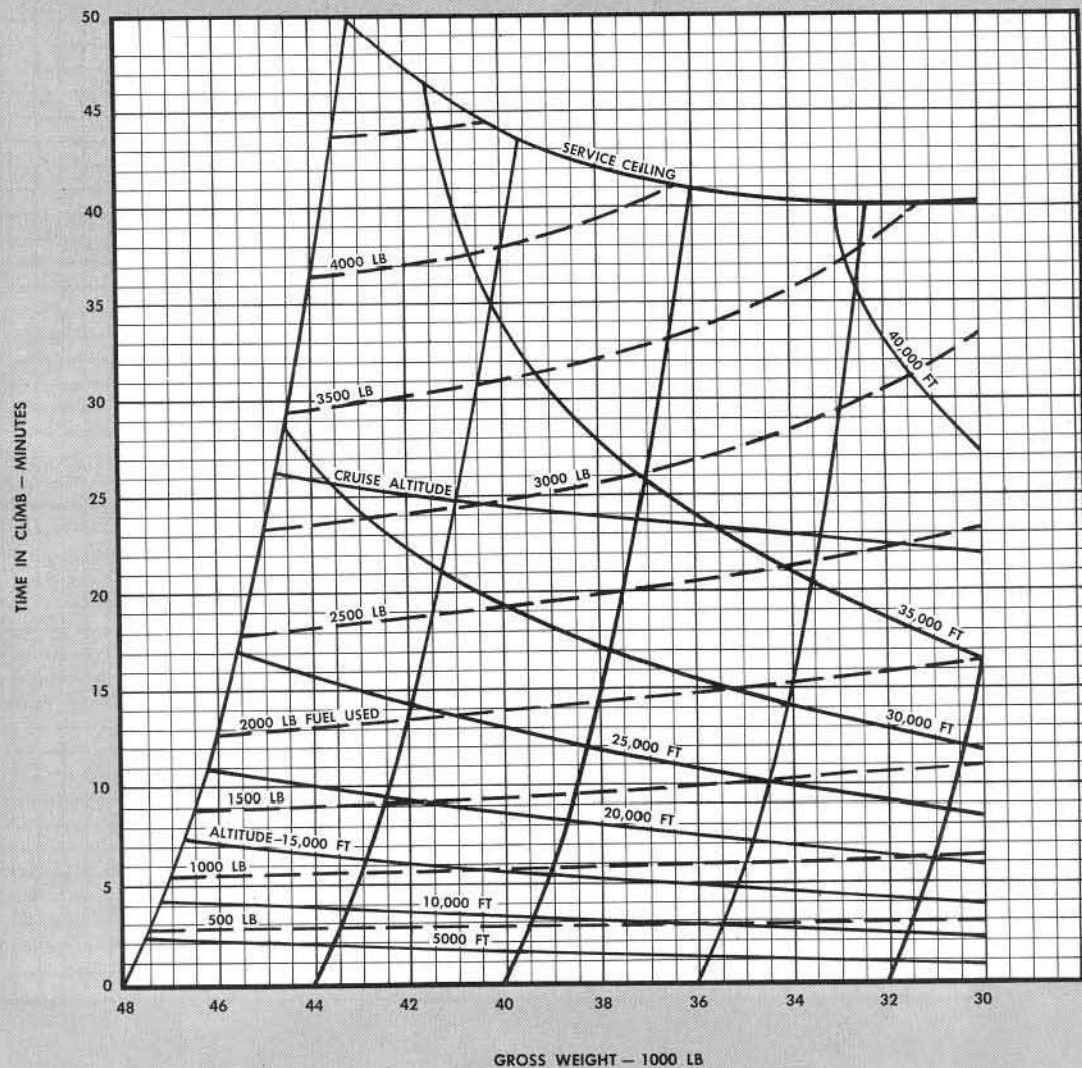
Figure A-16 (Sheet 4 of 9 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

MILITARY POWER
WITH PYLON TANKSJ35-35
OR
ENGINE(S): (2) J35-47FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-359

Figure A-16 (Sheet 5 of 9 Sheets).

BEST CLIMB SPEED

MODEL: F-89D

MILITARY POWER
WITH PYLON TANKS

J35-35

OR

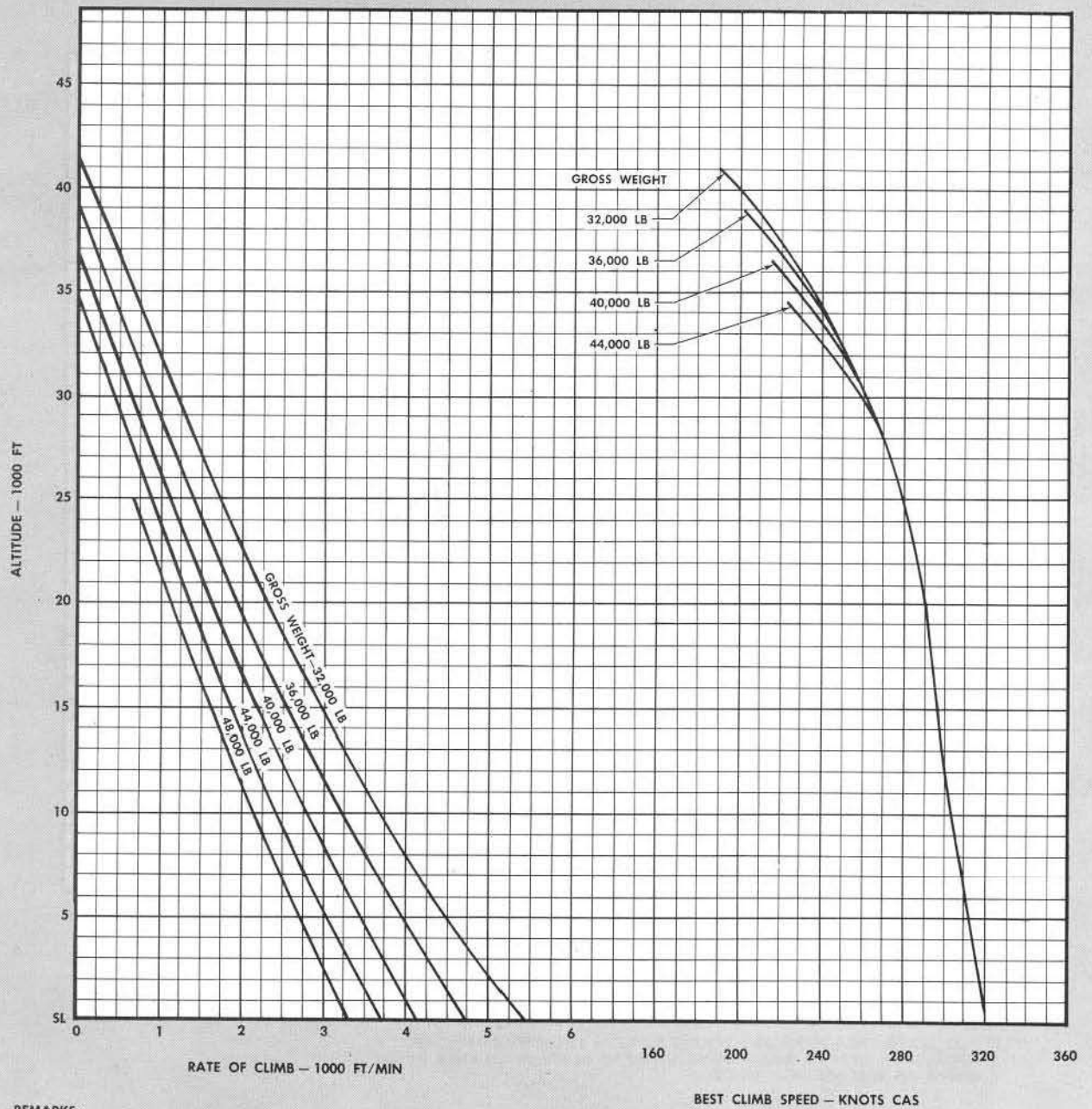
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



D-360

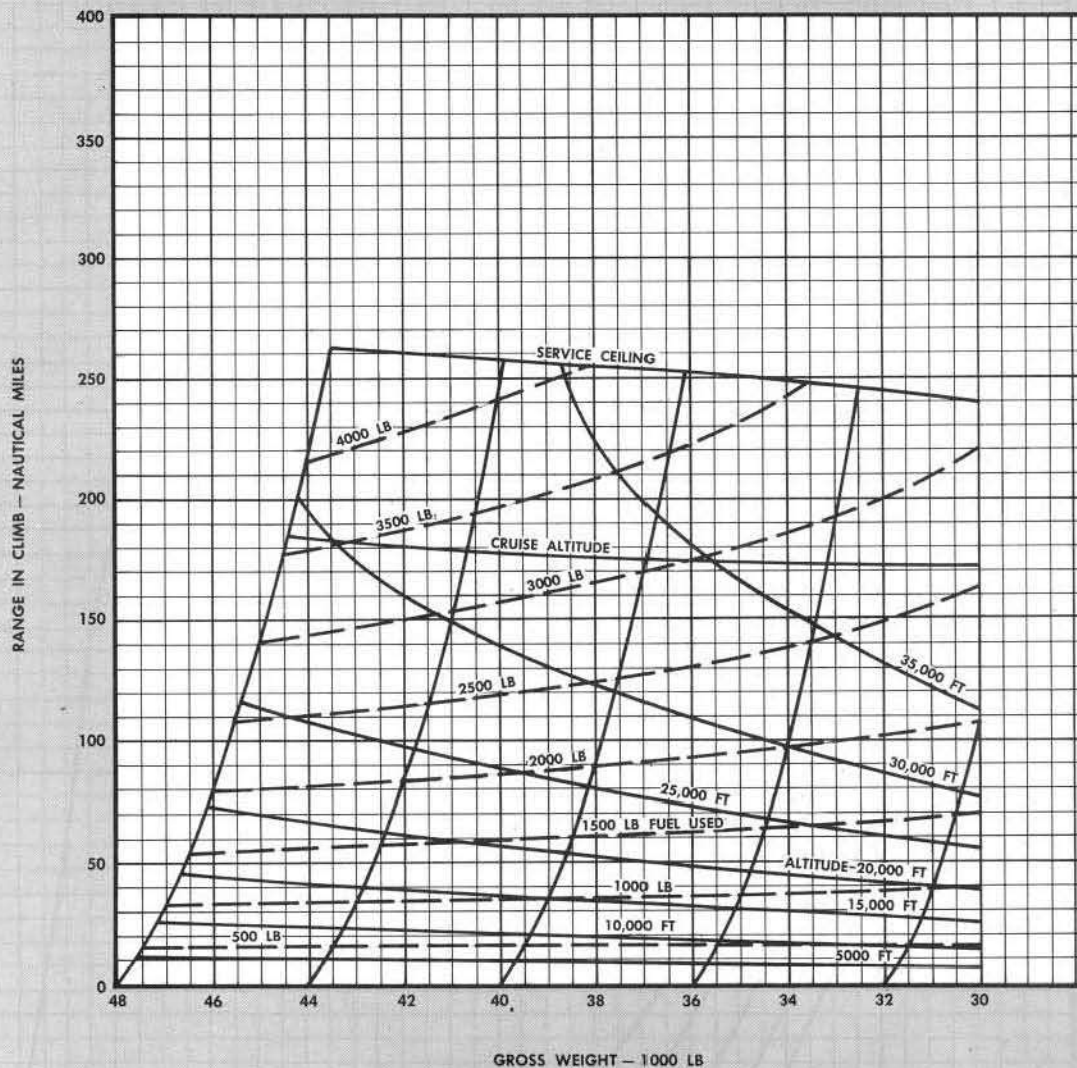
Figure A-16 (Sheet 6 of 9 Sheets).

BEST CLIMB PERFORMANCEMODEL: **F-89D**NORMAL POWER
WITH PYLON TANKSDATA BASIS: **FLIGHT TEST**DATE: **15 MARCH 56**

J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: **JP-4**FUEL DENSITY: **6.5 LB/US GAL**

REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-361

Figure A-16 (Sheet 7 of 9 Sheets).

BEST CLIMB PERFORMANCE

MODEL: F-89D

NORMAL POWER
WITH PYLON TANKS

J35-35

OR

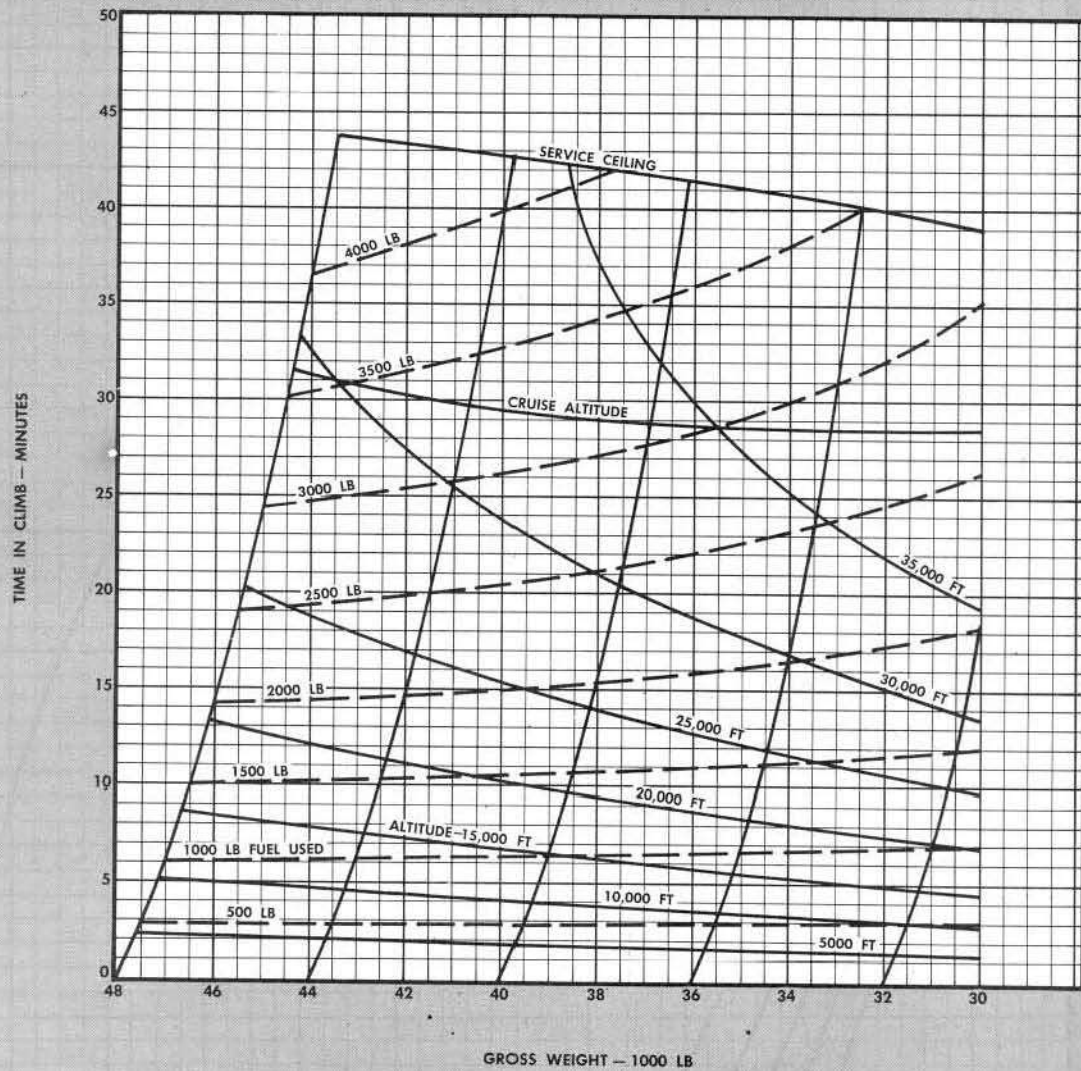
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 LB FROM TAKEOFF GROSS WEIGHT TO OBTAIN INITIAL CLIMB WEIGHT.
3. ENGINE AIR INLET SCREENS RETRACTED.

D-362

Figure A-16 (Sheet 8 of 9 Sheets).

BEST CLIMB SPEED

MODEL: F-89D

NORMAL POWER
WITH PYLON TANKS

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

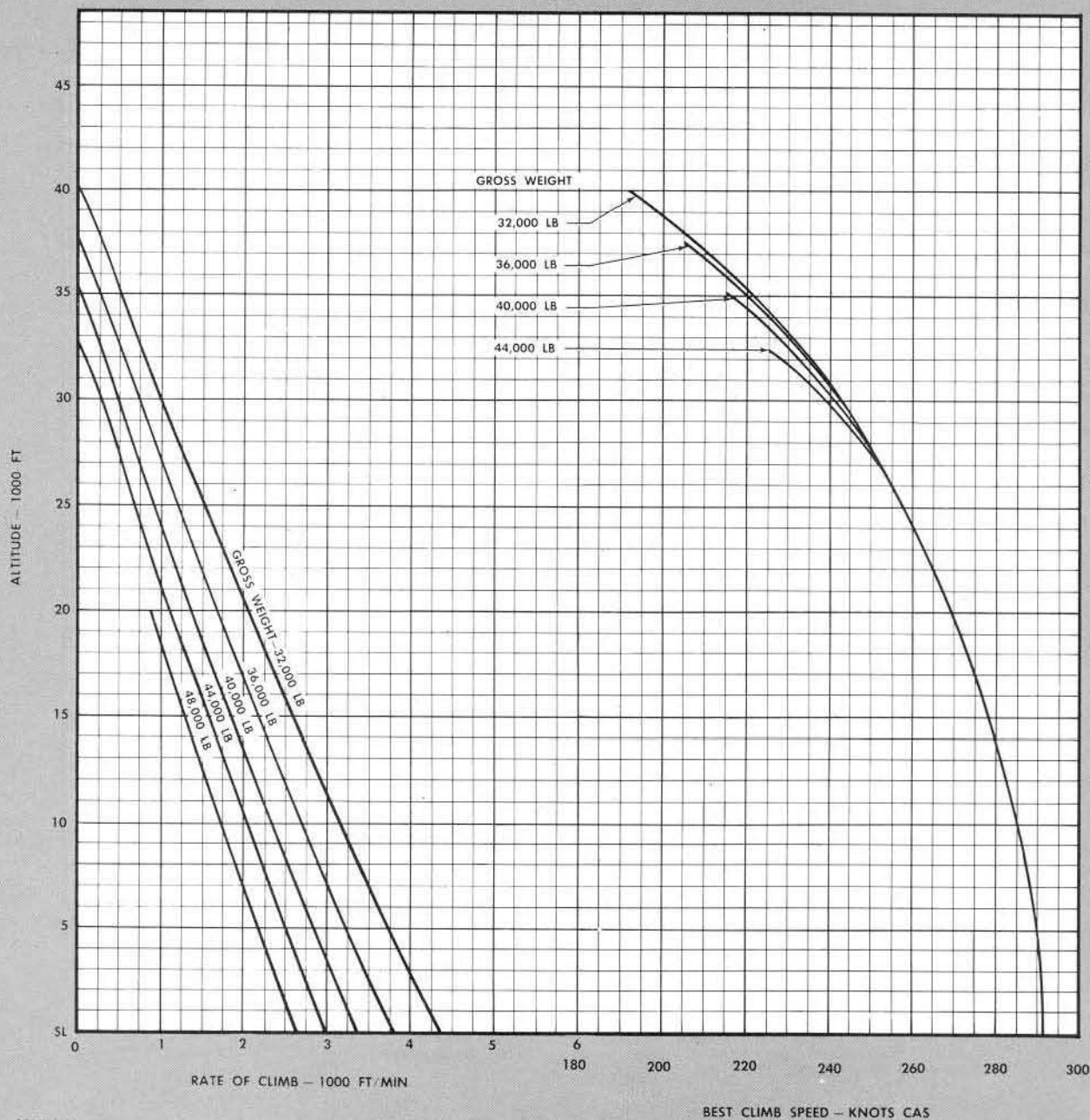
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

D-263

Figure A-16 (Sheet 9 of 9 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

SEA LEVEL
WITH PYLON TANKS

J35-35

OR

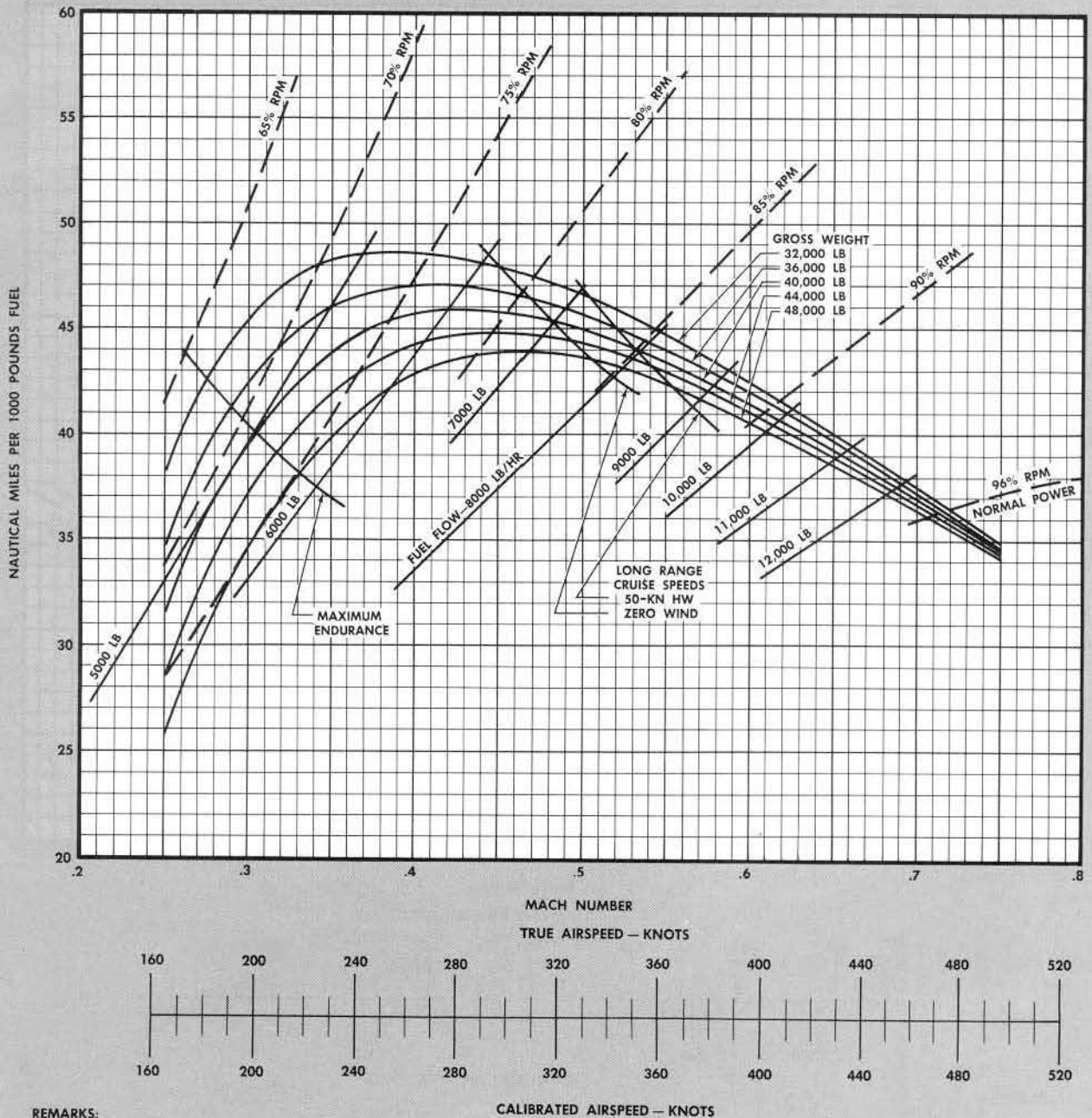
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-364

Figure A-17 (Sheet 1 of 8 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

5000 FEET
WITH PYLON TANKS

J35-35

OR

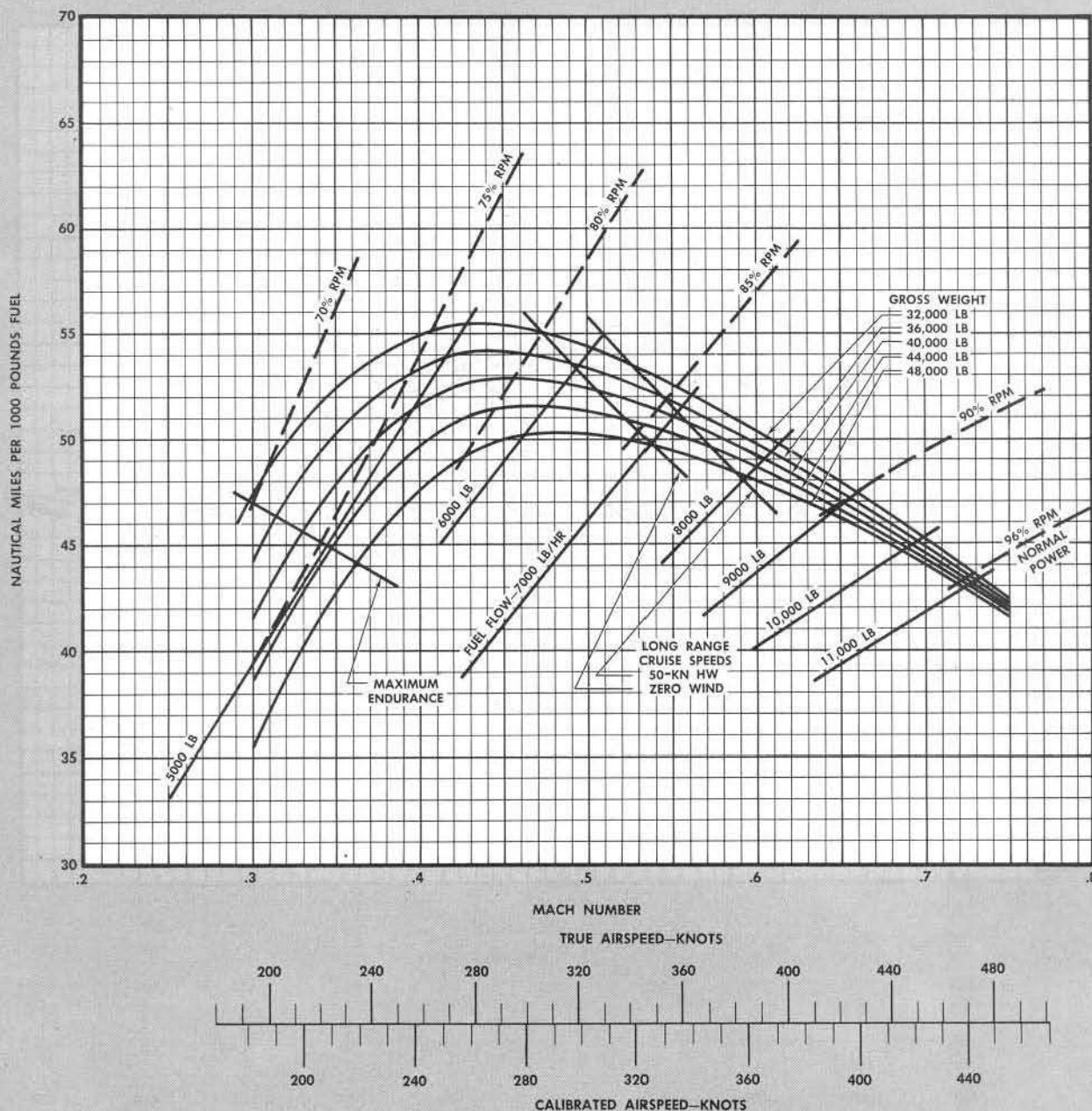
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-365

Figure A-17 (Sheet 2 of 8 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

10,000 FEET
WITH PYLON TANKS

J35-35

OR

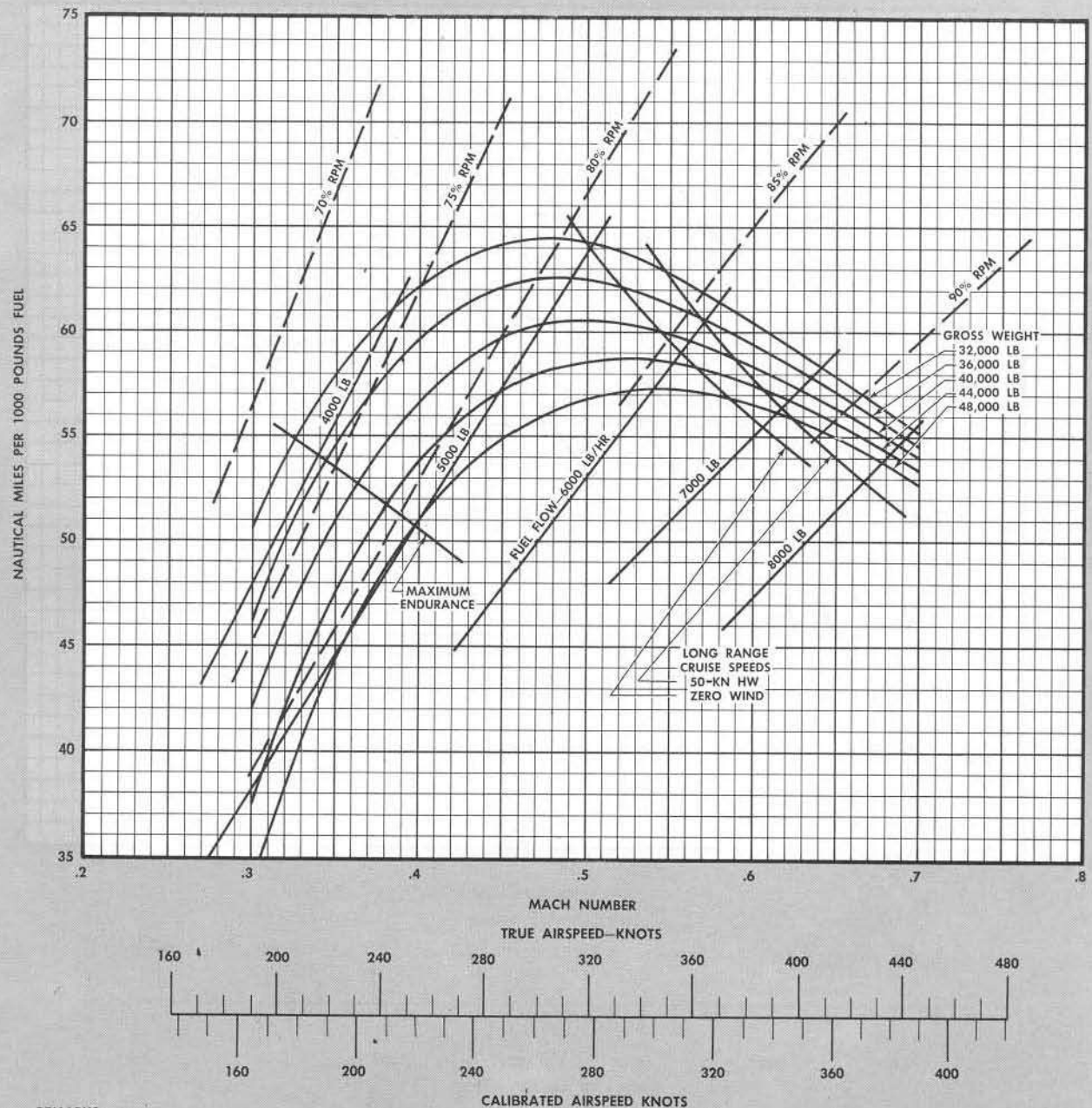
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-366

Figure A-17 (Sheet 3 of 8 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

15,000 FEET
WITH PYLON TANKSJ35-35
OR

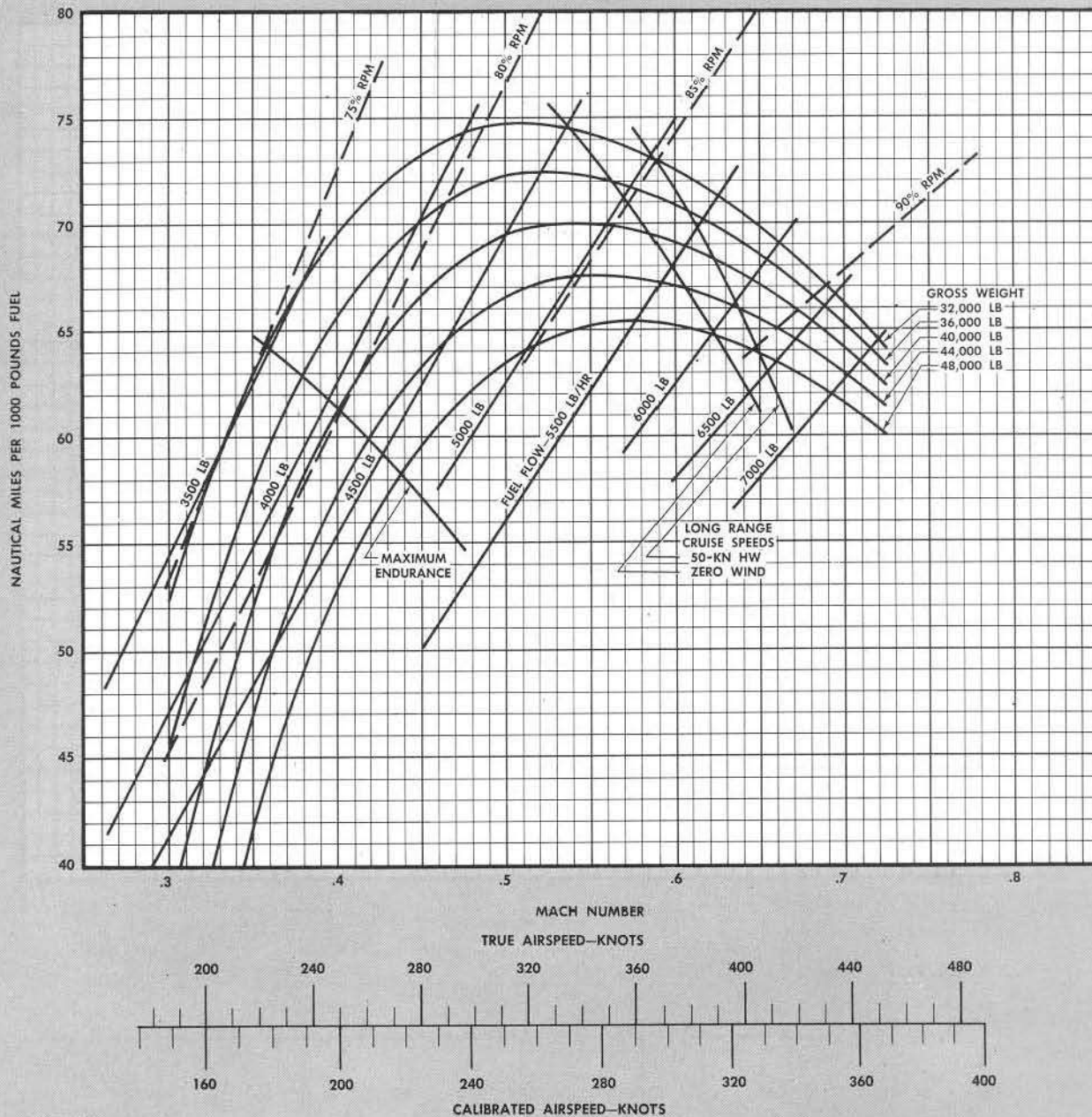
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSIT 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-367

Figure A-17 (Sheet 4 of 8 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

20,000 FEET
WITH PYLON TANKS

J35-35

OR

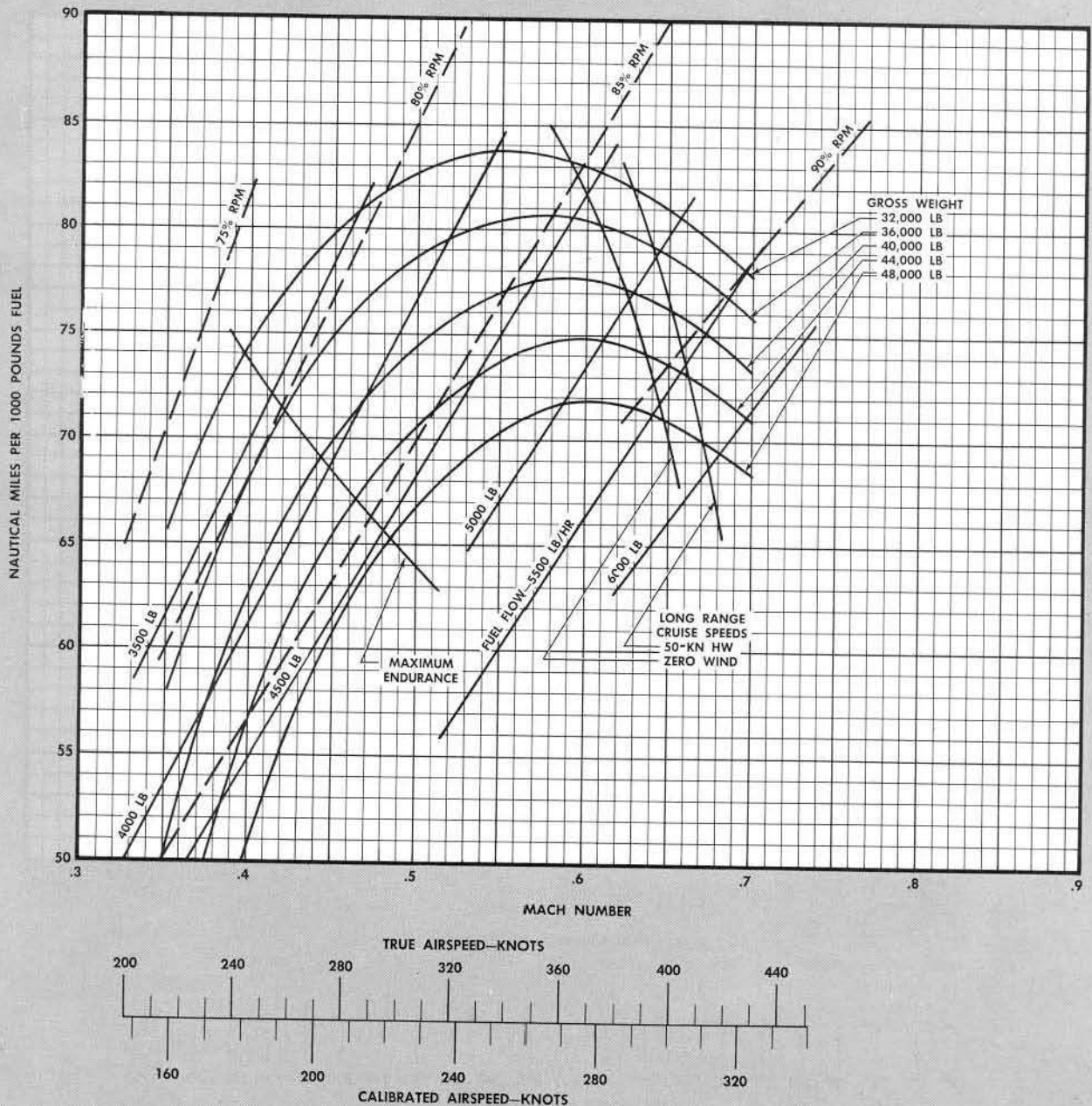
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-368

Figure A-17 (Sheet 5 of 8 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

25,000 FEET
WITH PYLON TANKS

J35-35

OR

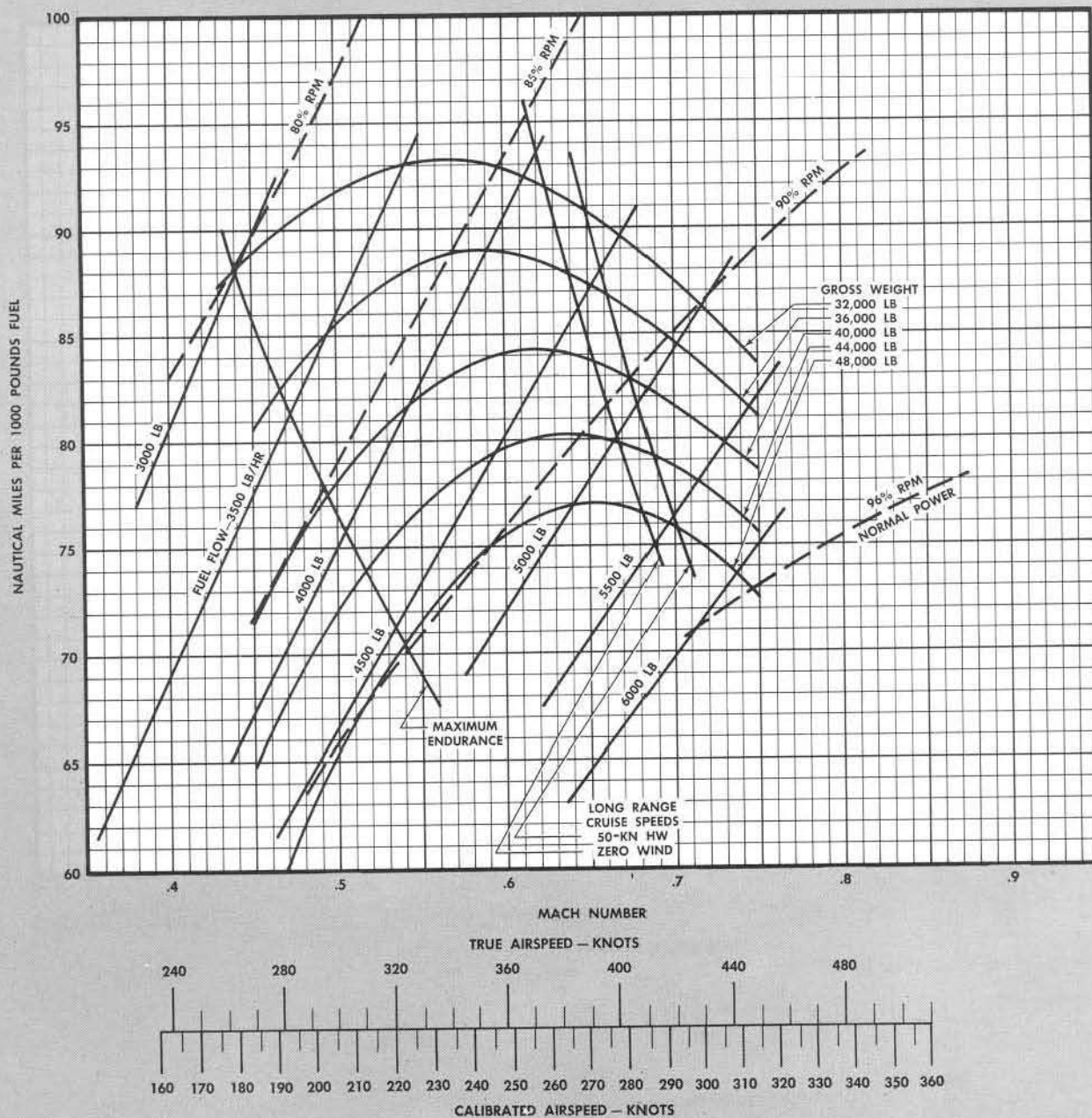
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREEN RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-369

Figure A-17 (Sheet 6 of 8 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

30,000 FEET
WITH PYLON TANKS

J35-35

OR

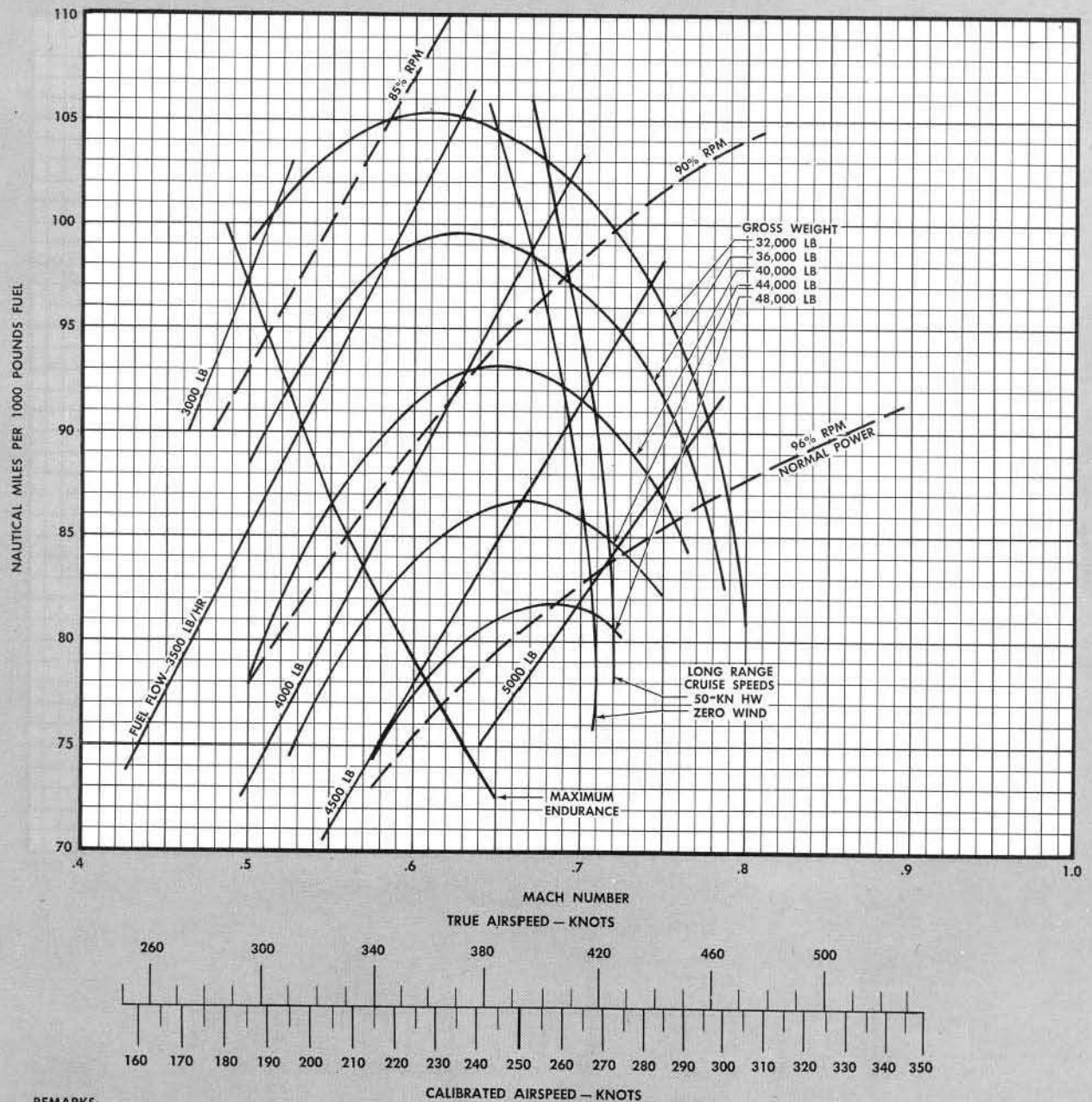
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-370

Figure A-17 (Sheet 7 of 8 Sheets).

NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89D

35,000 FEET
WITH PYLON TANKS

J35-35

OR

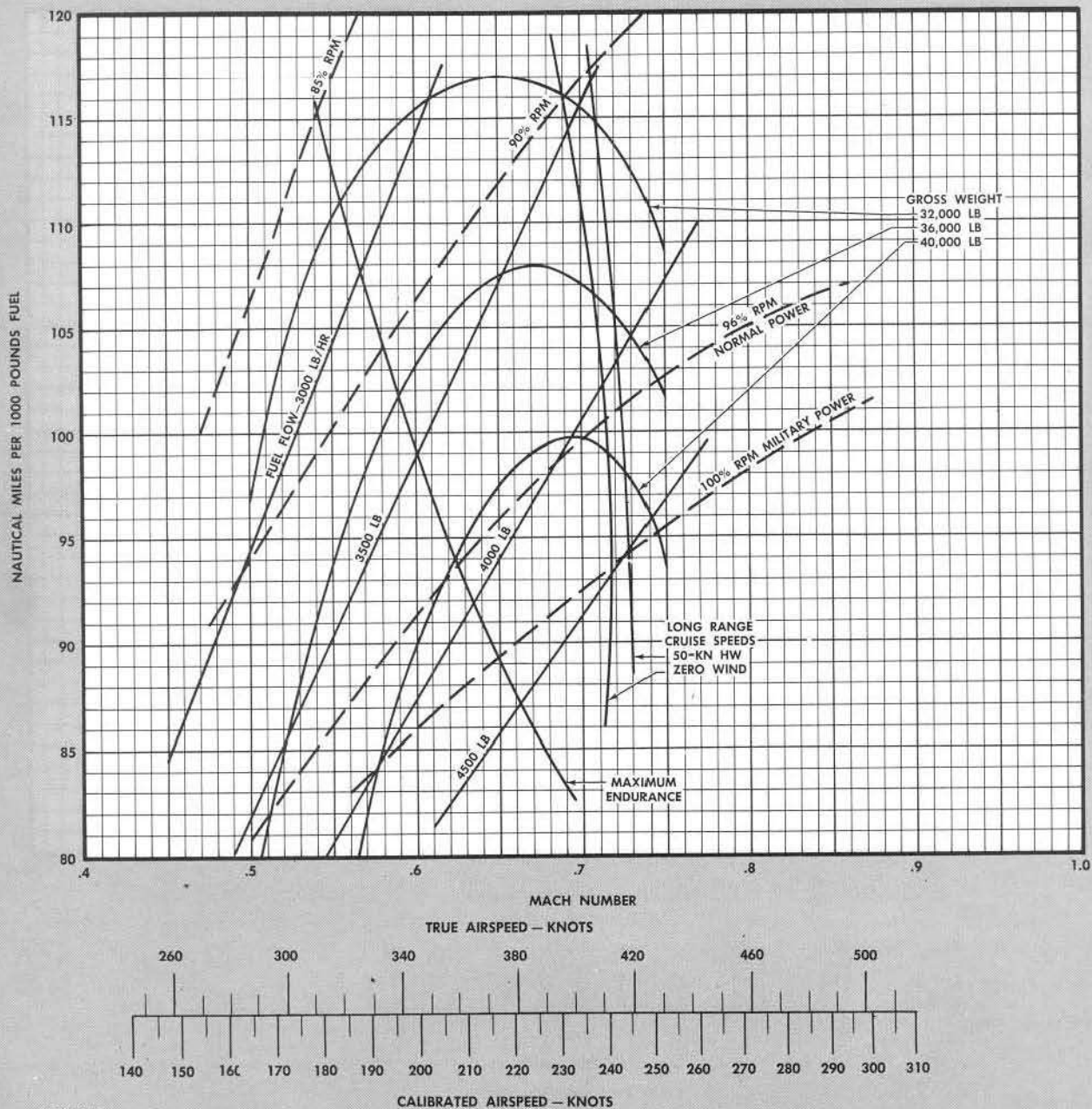
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

D-371

Figure A-1/ (Sheet 8 of 8 Sheets).

MISSION PROFILE

TAKEOFF GROSS WEIGHT

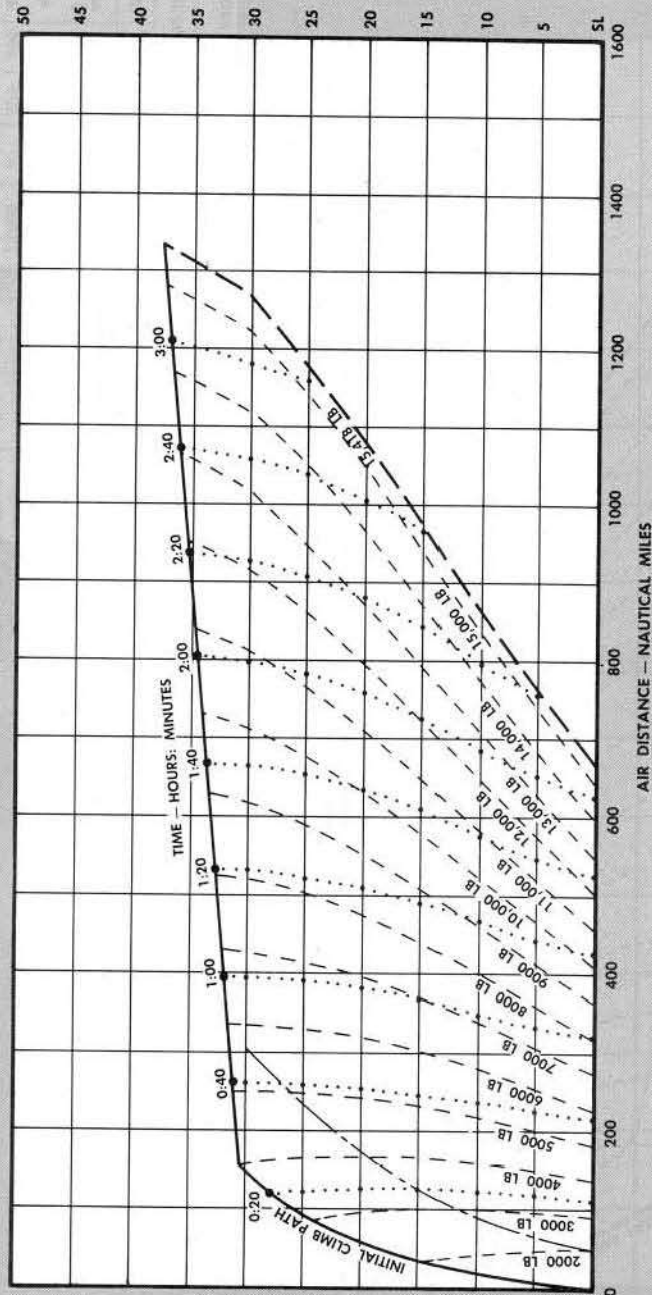
46,638 POUNDS

LONG RANGE CRUISE

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56MODEL: F-89D
ENGINE(S): (2) J35-35 or J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: PYLON TANKS CARRIED THROUGHOUT

MILITARY POWER		ALT 1000 FT
MACH NO.	CAS	
.69	260	45
.67	280	40
.63	290	35
.59	300	30
.55	300	25
.51	310	20
.48	320	15
		10
		5
		SL



REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF—906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MILITARY POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

— ZERO FUEL REMAINING

- - - FUEL CONSUMED

— CRUISE-CLIMB PATH

* * * * * TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)

- - - LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

CRUISE—WITH PYLON TANKS				
ALTITUDE FEET	MACH NO.	CAS	TAS	APPROXIMATE LB/HR % RPM
CRUISE - CLIMB	.70		405	4500 - *
30,000	.68	255	400	4100 90
25,000	.65	270	390	4400 88
20,000	.62	285	380	4800 87
15,000	.58	290	360	5200 85
10,000	.54	295	340	5600 83
5,000	.50	305	325	6200 82
SEA LEVEL	.48	315	315	6800 81

*

CRUISE-CLIMB PROCEDURE		
ALTITUDE FEET	% RPM	MACH NO.
31,000	94	.70
32,000	94	.70
33,000	94	.70
34,000	93	.70
35,000	93	.70
36,000	93	.70
37,000	92	.70

Figure A-18 (Sheet 1 of 2 Sheets).

MISSION PROFILE

TAKEOFF GROSS WEIGHT

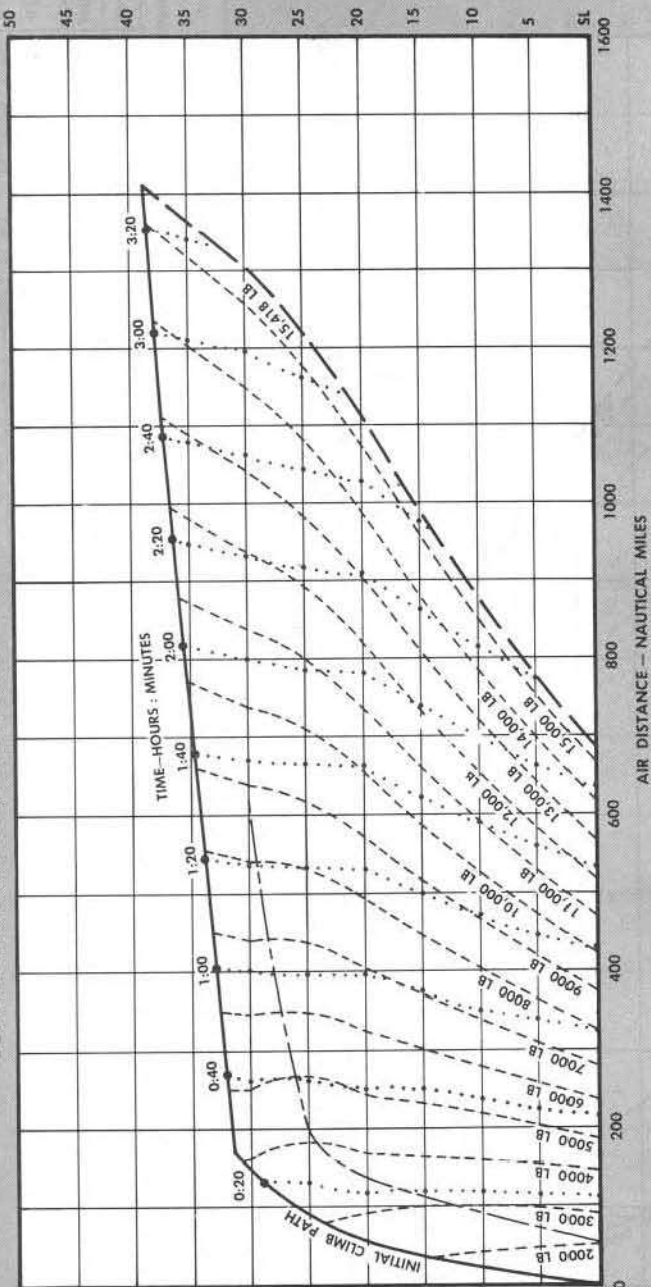
46,638 POUNDS

LONG RANGE CRUISE

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: PYLON TANKS DROPPED WHEN EMPTY

MILITARY POWER CLIMB		ALT 1000 FT
MACH NO.	CAS	
		45
		40
		35
.69	260	30
.67	280	25
.63	290	20
.59	300	15
.55	300	10
.51	310	5
.48	320	SL



REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF - 906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MILITARY POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

— ZERO FUEL REMAINING

- - - FUEL CONSUMED

— CRUISE-CLIMB PATH

..... TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)

- - - LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

CRUISE - PYLON TANKS DROPPED WHEN EMPTY					
ALTITUDE FEET	MACH NO.	CAS	TAS	LB/HR	% RPM
CRUISE-CLIMB	.71			4400	NOTE
30,000	.70	260	410	4400	92
25,000	.67	275	400	4600	89
20,000	.64	290	390	4900	87
15,000	.60	305	375	5200	86
10,000	.56	310	355	5700	85
5,000	.52	315	335	6200	83
SEA LEVEL	.49	325	325	6900	81

CRUISE-CLIMB PROCEDURE		
ALTITUDE FEET	% RPM	MACH NO.
32,000	94	.71
33,000	93	.71
34,000	93	.71
35,000	93	.71
36,000	93	.71
37,000	93	.71
38,000	92	.71

Figure A-18 (Sheet 2 of 2 Sheets).

INTERCEPT PROFILE

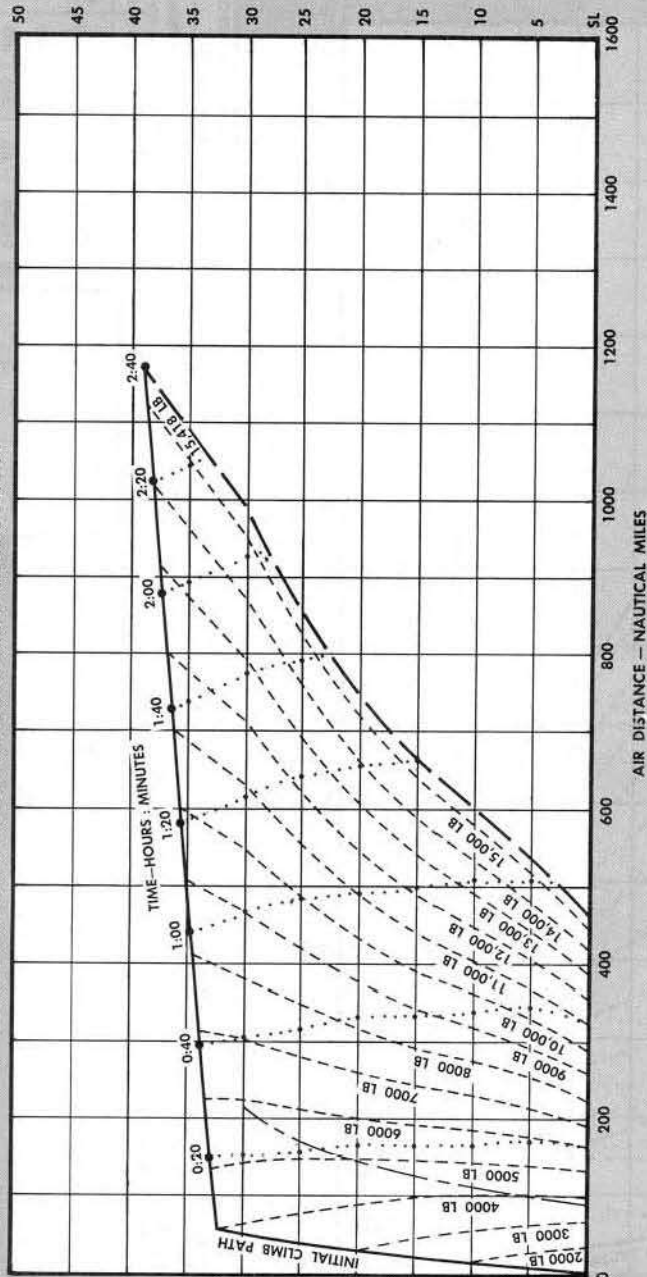
TAKEOFF GROSS WEIGHT
46,638 POUNDS
MILITARY POWER CRUISE

MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56

MACH NO.	MAXIMUM POWER CLIMB		ALT 1000 FT
	CAS		
.76	290		45
.76	320		40
.76	350		35
.75	380		30
.73	410		25
.70	430		20
.66	430		15
			10
			5
			SL

CONFIGURATION: PYLON TANKS CARRIED THROUGHOUT



AIR DISTANCE - NAUTICAL MILES

REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF - 906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MAXIMUM POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

— ZERO FUEL REMAINING

--- FUEL CONSUMED

— CRUISE-CLIMB PATH

..... TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)

— LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

CRUISE - PYLON TANKS CARRIED THROUGHOUT				
ALTITUDE FEET	MACH NO.	APPROXIMATE		
		CAS	TAS	LB/HR
CRUISE-CLIMB	*			5,100-3,800
30,000	.79	300	465	5,700
25,000	.80	335	480	7,100
20,000	.80	370	490	8,500
15,000	.80	410	500	10,100
10,000	.79	440	505	11,600
5,000	.78	475	510	13,300
SEA LEVEL	.72	475	475	15,000

*

CRUISE-CLIMB PROCEDURE		
ALTITUDE FEET	% RPM	MACH NO.
32,000	100	.75
33,000	100	.75
34,000	100	.75
35,000	100	.75
36,000	100	.76
37,000	100	.76
38,000	100	.76
39,000	100	.76

Figure A-19 (Sheet 1 of 2 Sheets).

INTERCEPT PROFILE

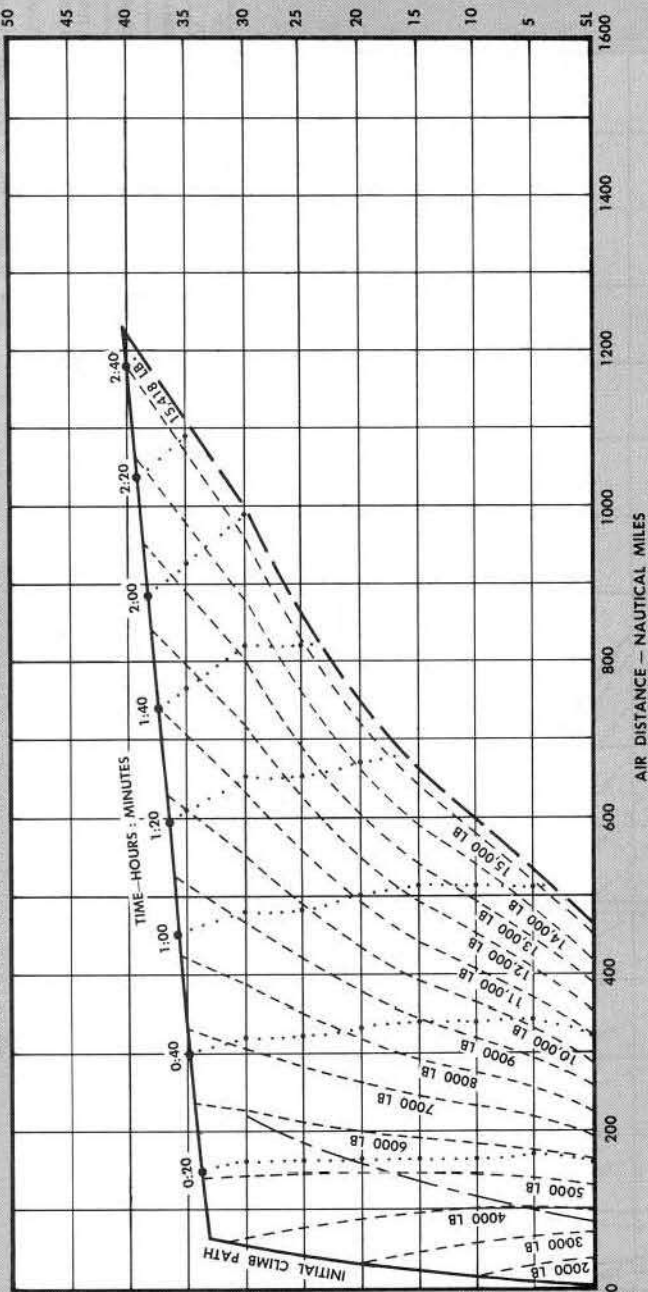
TAKEOFF GROSS WEIGHT
46,638 POUNDS
MILITARY POWER CRUISE

MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56

MAXIMUM POWER CLIMB		MACH NO.	CAS	ALT 1000 FT
				45
				40
				35
.79	270			30
.76	290			25
.76	320			20
.76	350			15
.75	380			10
.73	410			5
.70	430			SL
.66	430			SL

CONFIGURATION: PYLON TANKS DROPPED WHEN EMPTY



REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF - 906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MAXIMUM POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- ZERO FUEL REMAINING
- - - FUEL CONSUMED
- CRUISE-CLIMB PATH
- TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
- LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

CRUISE - PYLON TANKS DROPPED WHEN EMPTY				
ALTITUDE FEET	MACH NO.	APPROXIMATE		
		CAS	TAS	LB/HR
CRUISE-CLIMB	.77			4,900-3,700
30,000	.82	310	480	5,900
25,000	.82	350	495	7,200
20,000	.82	385	505	8,700
15,000	.82	425	515	10,300
10,000	.82	460	520	11,800
5,000	.78	475	510	13,300
SEA LEVEL	.72	475	475	15,000

CRUISE-CLIMB PROCEDURE		
ALTITUDE FEET	% RPM	MACH NO.
33,000	100	.77
34,000	100	.77
35,000	100	.77
36,000	100	.77
37,000	100	.77
38,000	100	.77
39,000	100	.77
40,000	100	.77

Figure A-19 (Sheet 2 of 2 Sheets).

OPTIMUM RETURN PROFILE

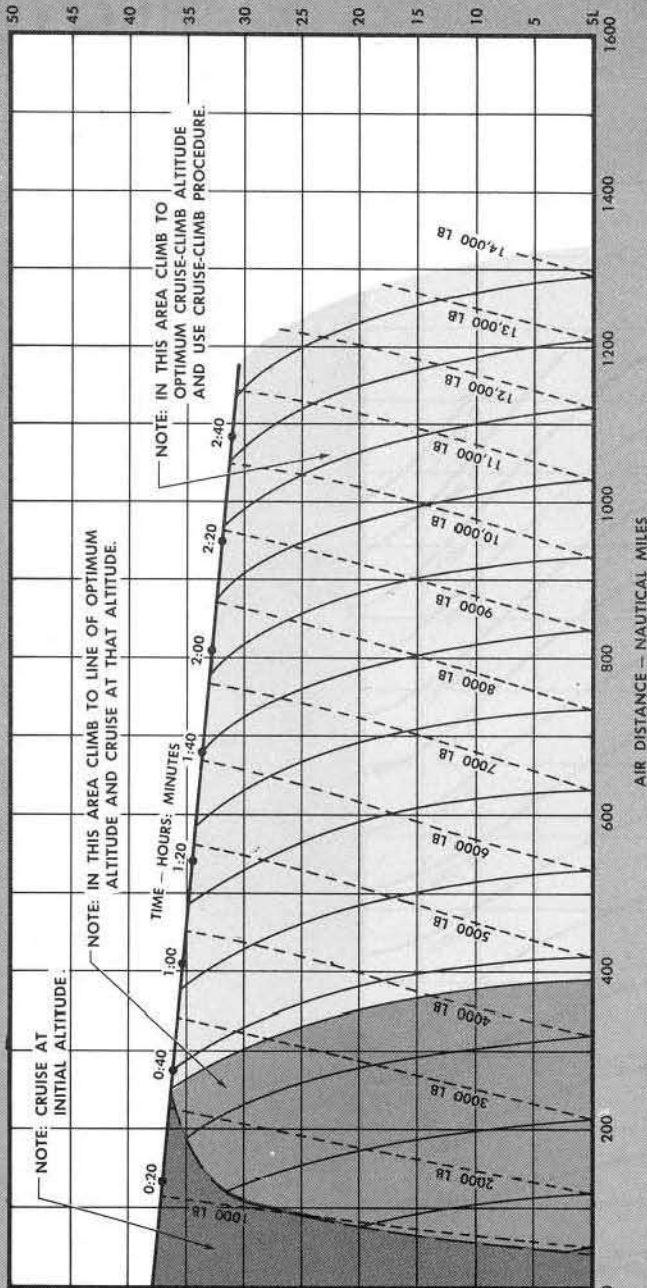
TAKEOFF GROSS WEIGHT

46,638 POUNDS

DATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56MODEL: F-89D
ENGINE(S): (2) J35-35 OR J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: WITH PYLON TANKS

MACH NO.	MILITARY POWER CLIMB		ALT 1000 FT
	CAS	ALT 1000 FT	
.70	230	45	
.69	260	40	
.67	280	35	
.63	290	30	
.59	300	25	
.55	300	20	
.51	310	15	
.48	320	10	
	320	5	
	320	SL	



REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO FLIGHT ALTITUDE (IF BELOW THAT).
2. NO ALLOWANCE MADE FOR LOITER, DESCENT, OR LANDING.
3. BEST CRUISE CONDITION DETERMINED BY INTERSECTION OF CLIMB PATH GUIDE LINES AND LINES OF BEST RANGE.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

• TIME AT CRUISE-CLIMB ALTITUDE

--- FUEL REQUIRED

--- CLIMB PATH GUIDE LINE

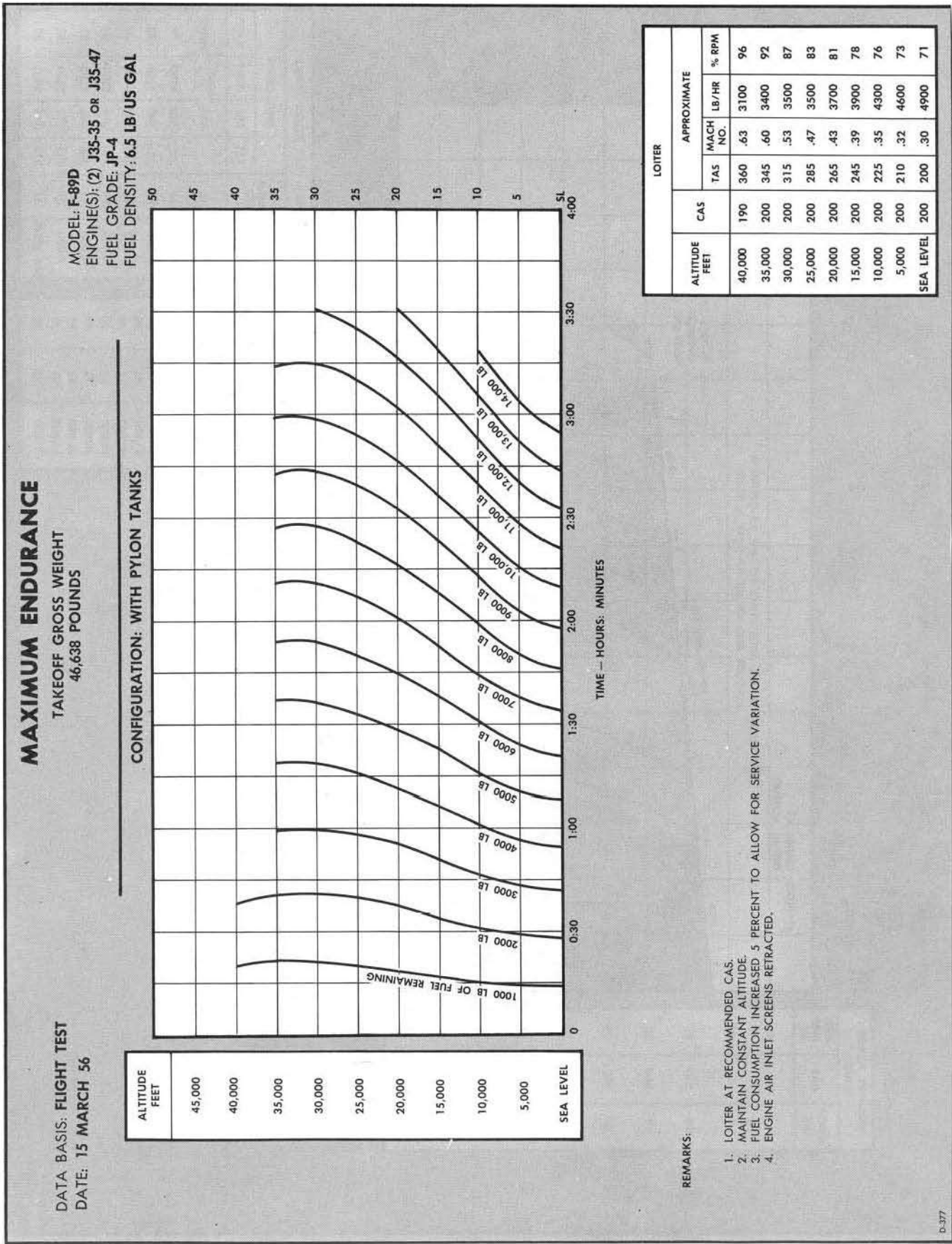
--- LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

--- LINE OF BEST RANGE FOR CRUISE-CLIMB FLIGHT

ALTITUDE FEET	MACH NO.	APPROXIMATE			NOTE
		CAS	TAS	LB/HR	
CRUISE - CLIMB	.70				4500 - 3500
30,000	.68	255	400	4100	90
25,000	.65	270	390	4400	88
20,000	.62	285	380	4800	87
15,000	.58	290	360	5200	85
10,000	.54	295	340	5600	83
5,000	.50	305	325	6200	82
SEA LEVEL	.48	315	315	6800	81

ALTITUDE FEET	% RPM	MACH NO.
31,000	94	.70
32,000	94	.70
33,000	94	.70
34,000	93	.70
35,000	93	.70
36,000	93	.70
37,000	92	.70

Figure A-20.



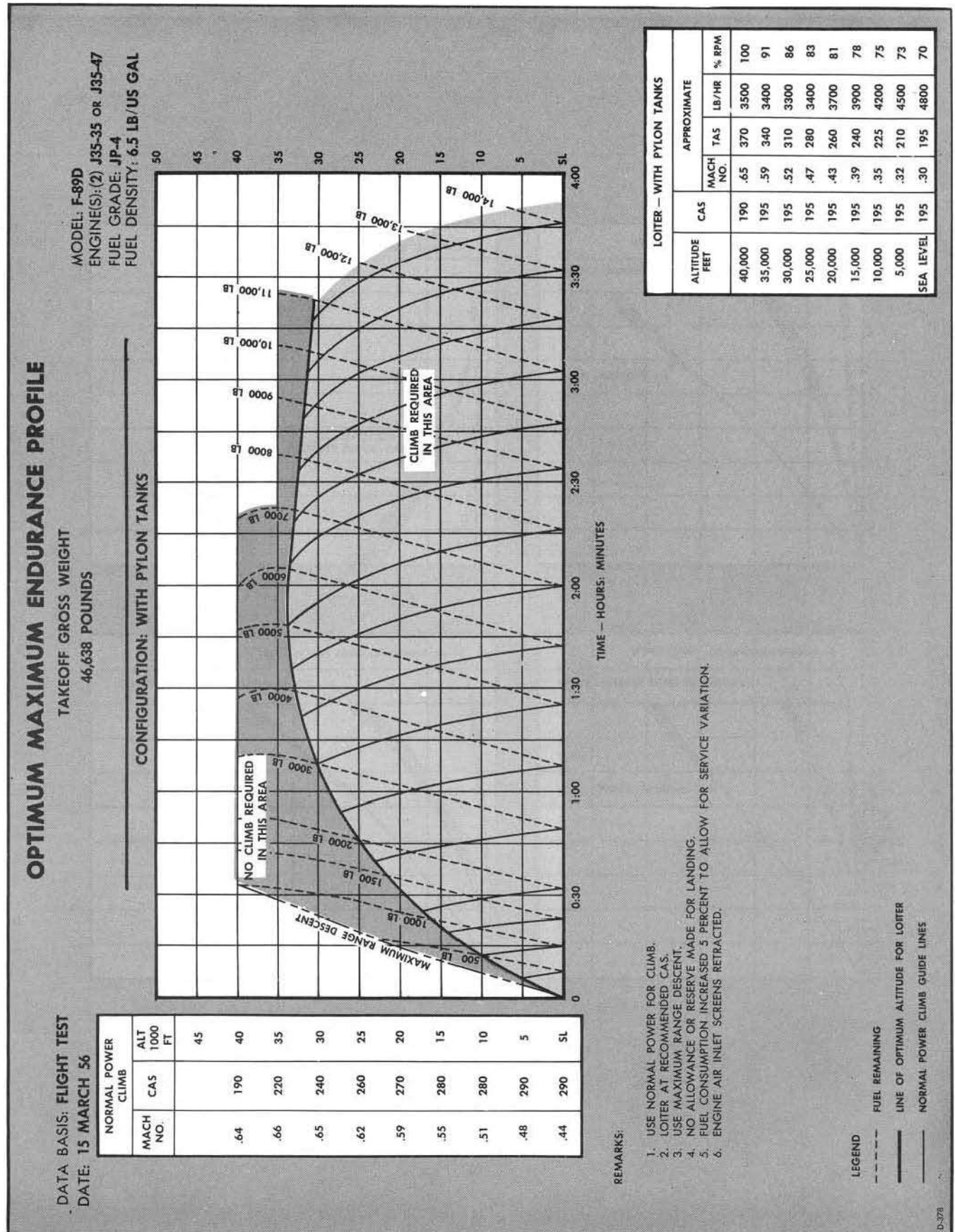
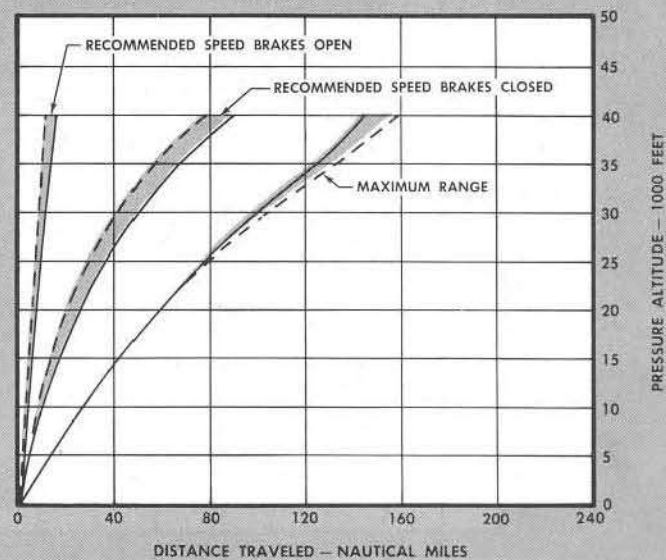
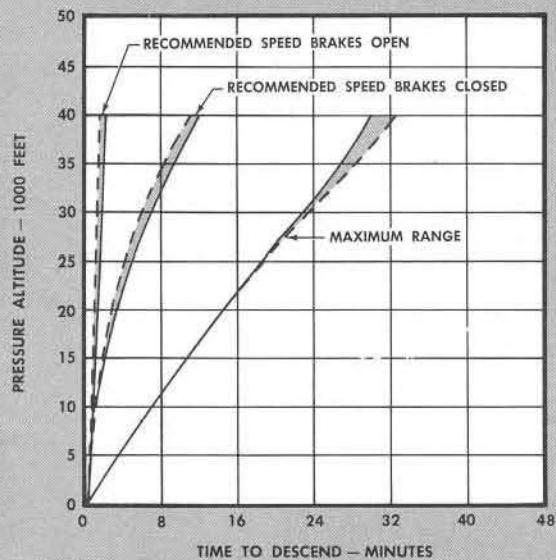
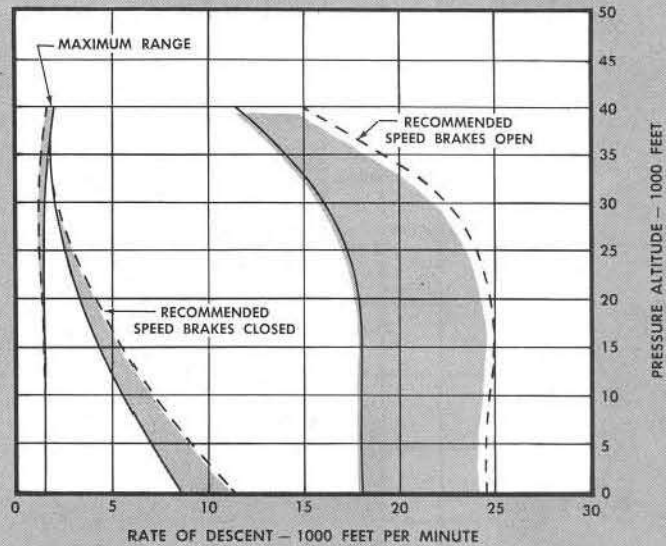
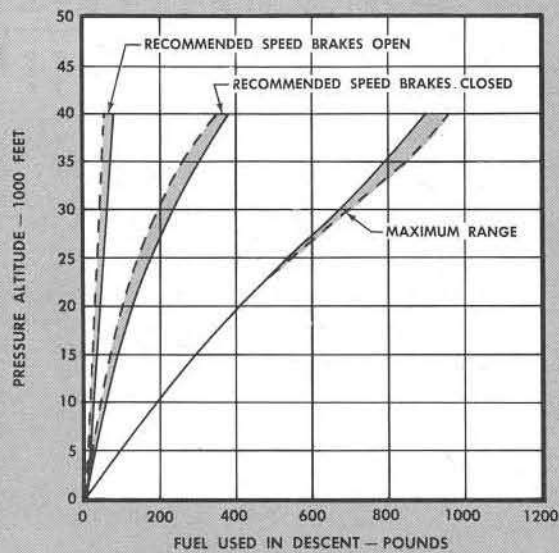


Figure A-22.

DESCENTS

MODEL: F-89D

WITH OR WITHOUT PYLON TANKS
IDLE POWERDATA BASIS: FLIGHT TEST
DATE: 15 MARCH 56J35-35
OR
ENGINE(S) (2) J35-47
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

REMARKS:

1. FOR MAXIMUM RANGE DESCENT, MAINTAIN 208 KNOTS INDICATED AIRSPEED (IAS).
2. FOR RECOMMENDED DESCENT, MAINTAIN 0.7 MACH NUMBER (SPEED BRAKES OPEN OR CLOSED).
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.

————— 44,000 LB
 - - - - - 32,000 LB

Figure A-23 (Sheet 1 of 2 Sheets).

DESCENTS

MODEL: F-89D

ONE ENGINE OPERATING
NO EXTERNAL LOAD
IDLE POWER

J35-35

OR

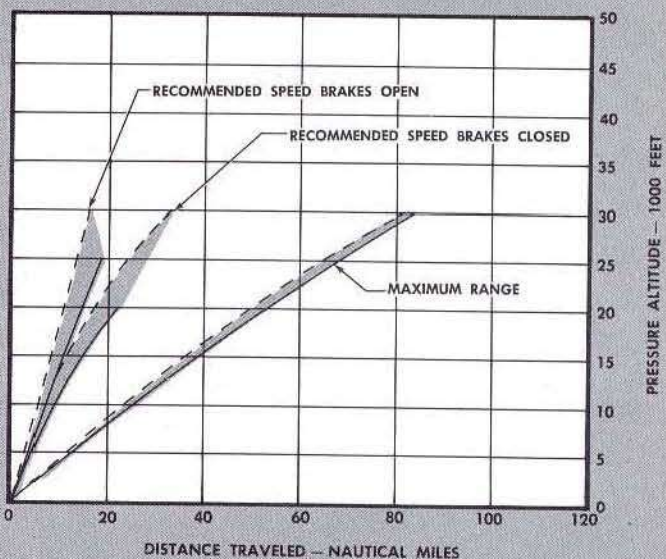
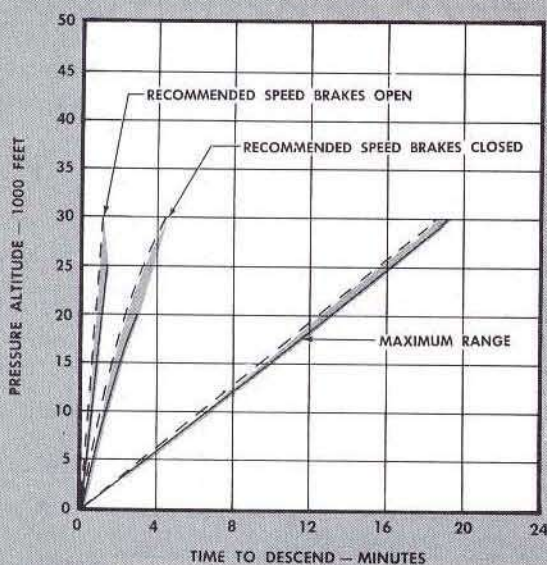
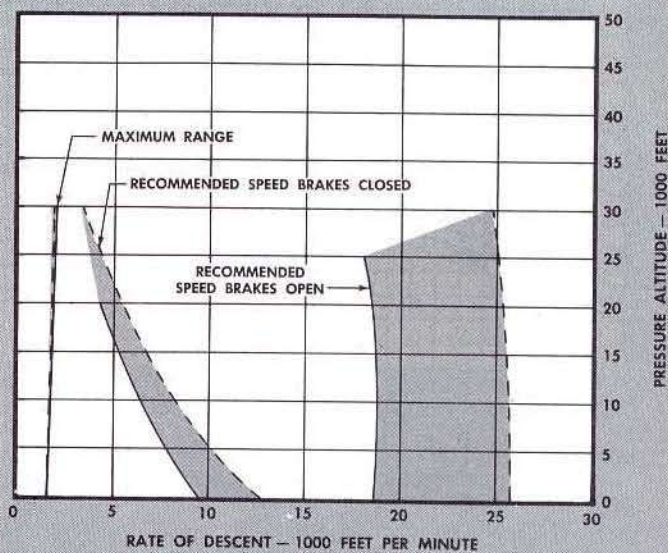
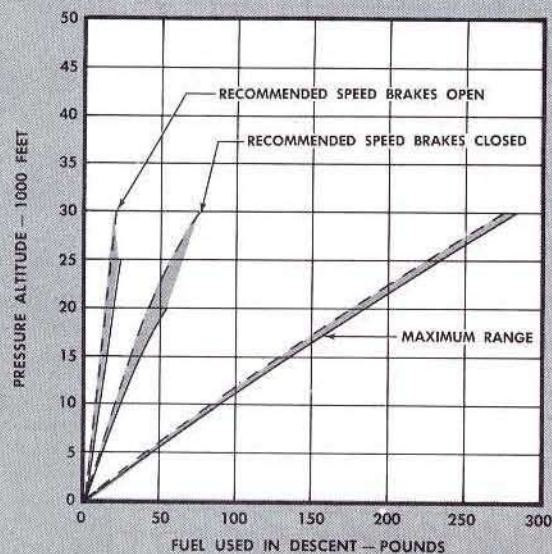
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



REMARKS:

1. FOR MAXIMUM RANGE DESCENT, MAINTAIN 208 KNOTS INDICATED AIRSPEED (IAS).
2. FOR RECOMMENDED DESCENT, MAINTAIN 0.7 MACH NUMBER (SPEED BRAKES OPEN OR CLOSED).
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.
5. SINGLE-ENGINE DESCENTS NOT RECOMMENDED BECAUSE OF THE POSSIBILITY OF "DUCT RUMBLE" ON THE WINDMILLING ENGINE.

—— 44,000 LB
 --- 32,000 LB

Figure A-23 (Sheet 2 of 2 Sheets).

LANDING DISTANCE

WITH OR WITHOUT PYLON TANKS (*)

MODEL: F-89D

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

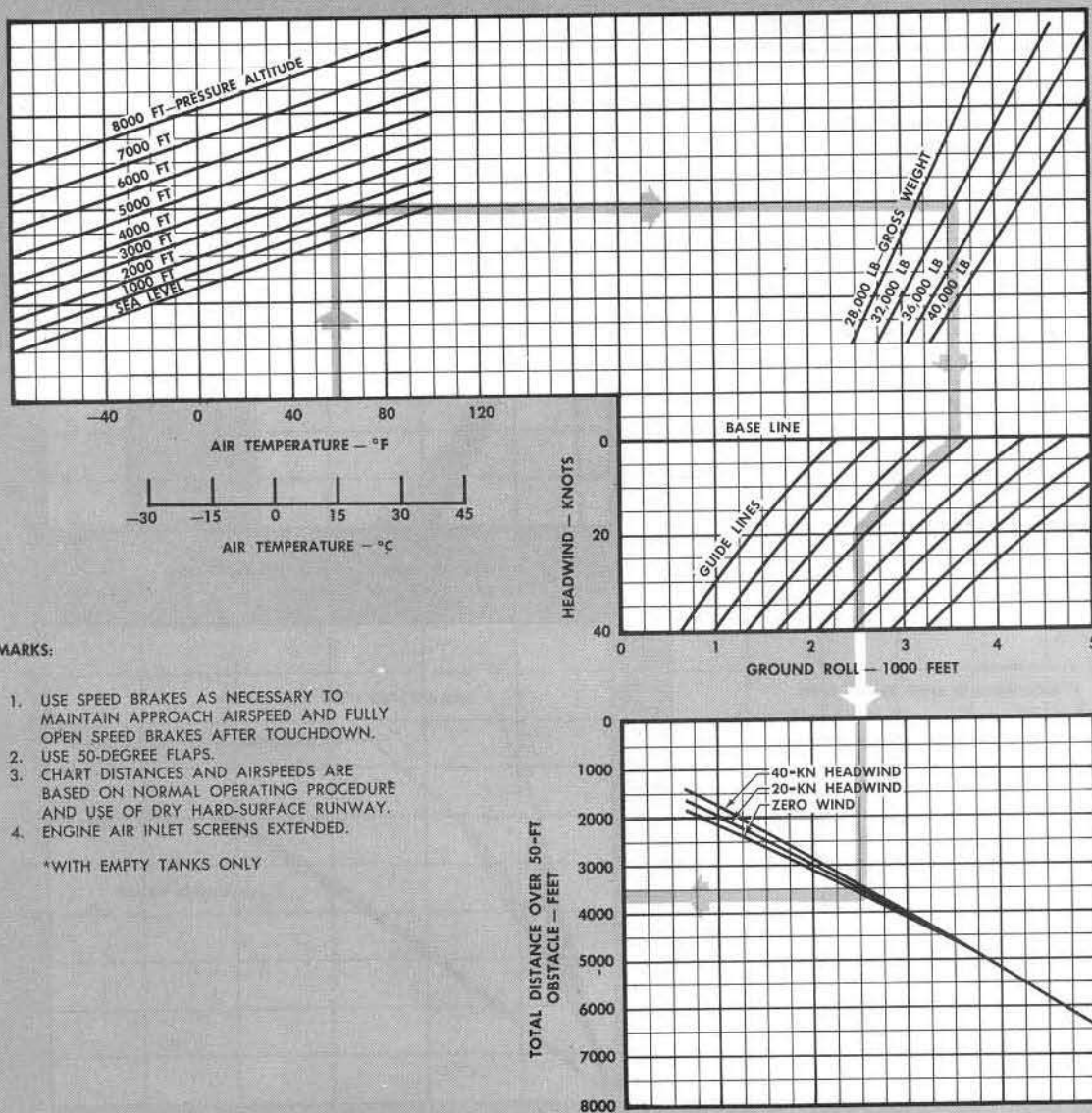
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



IAS — KNOTS			
GROSS WEIGHT	FINAL APPROACH	50-FT OBSTACLE	TOUCH-DOWN
28,000 LB	133	115	106
32,000 LB	143	124	114
36,000 LB	152	131	121
38,760 LB	157	136	126

Figure A-24 (Sheet 1 of 2 Sheets).

LANDING DISTANCE

MODEL: F-89D

NO EXTERNAL LOAD
ONE ENGINE OPERATING

J35-35

OR

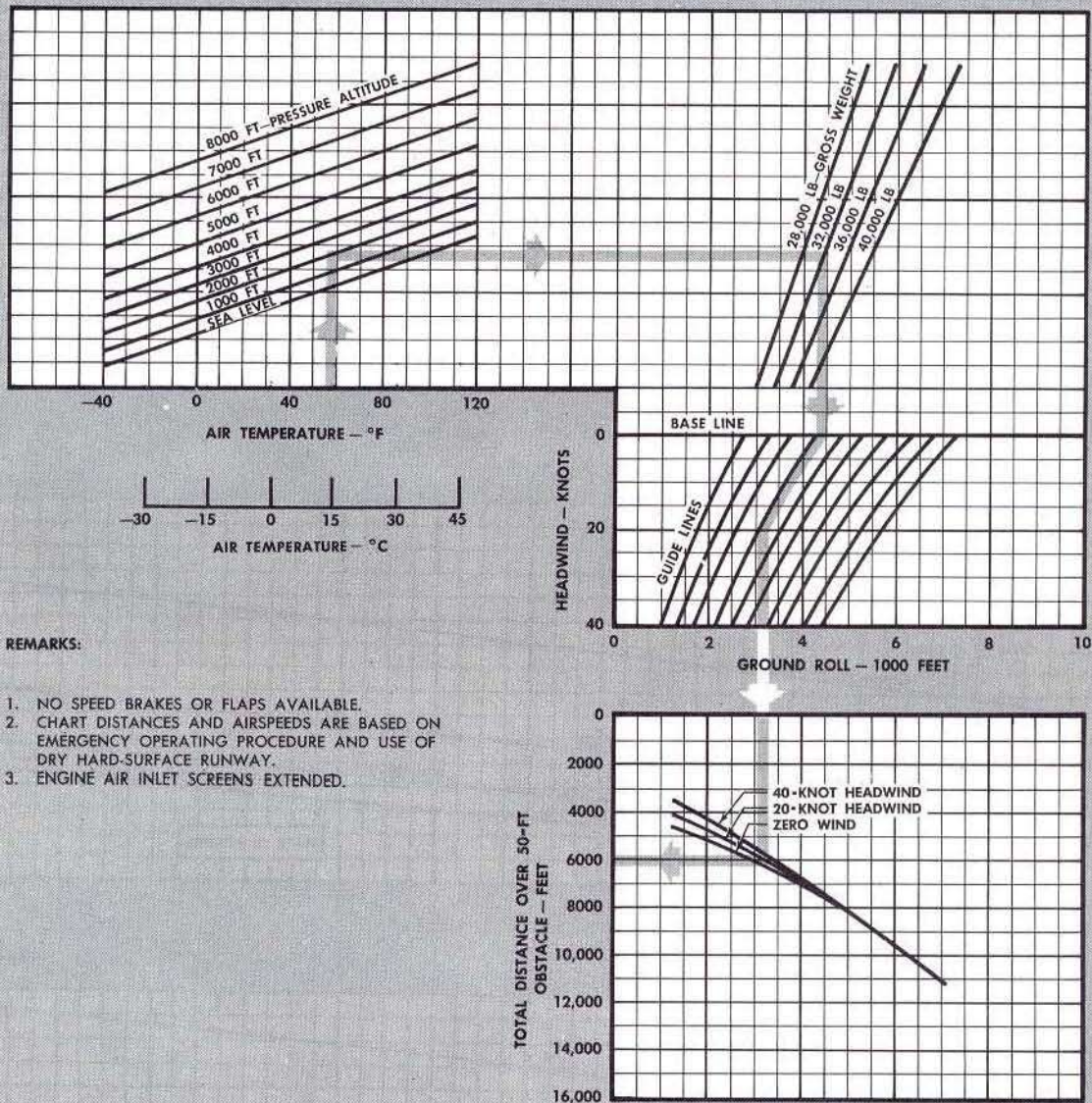
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



IAS — KNOTS			
GROSS WEIGHT	FINAL APPROACH	50-FT OBSTACLE	TOUCH-DOWN
28,000	156	133	121
32,000	164	141	129
36,000	173	149	137
38,760	179	155	142

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Figure A-24 (Sheet 2 of 2 Sheets).

LANDING SPEEDS

WITH OR WITHOUT PYLON TANKS

MODEL: F-89D

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

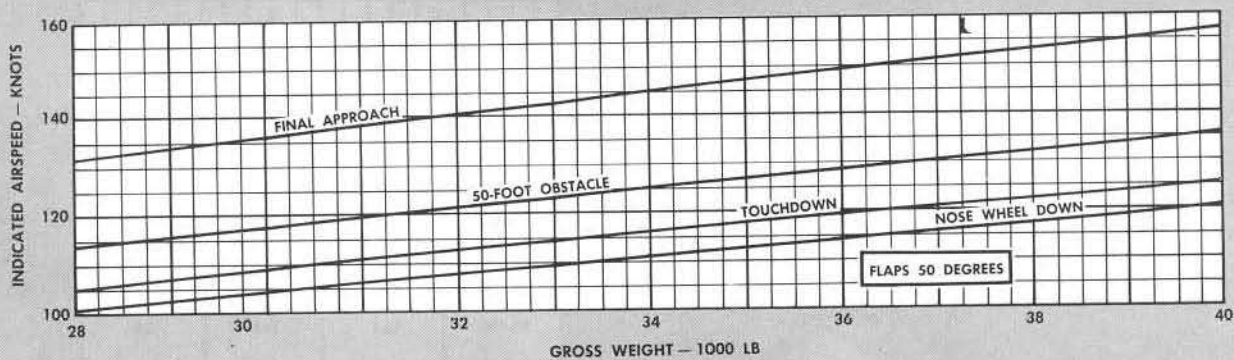
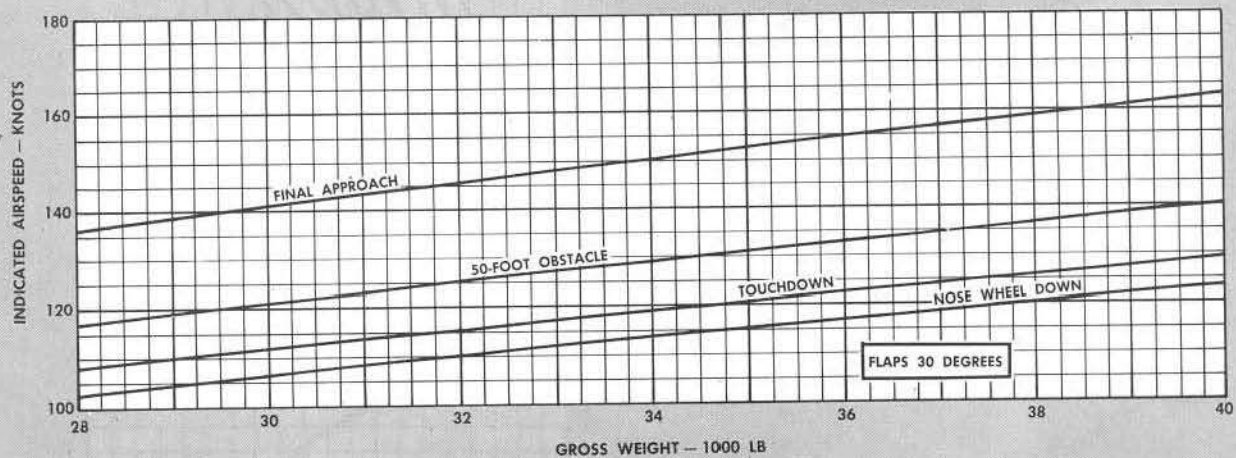
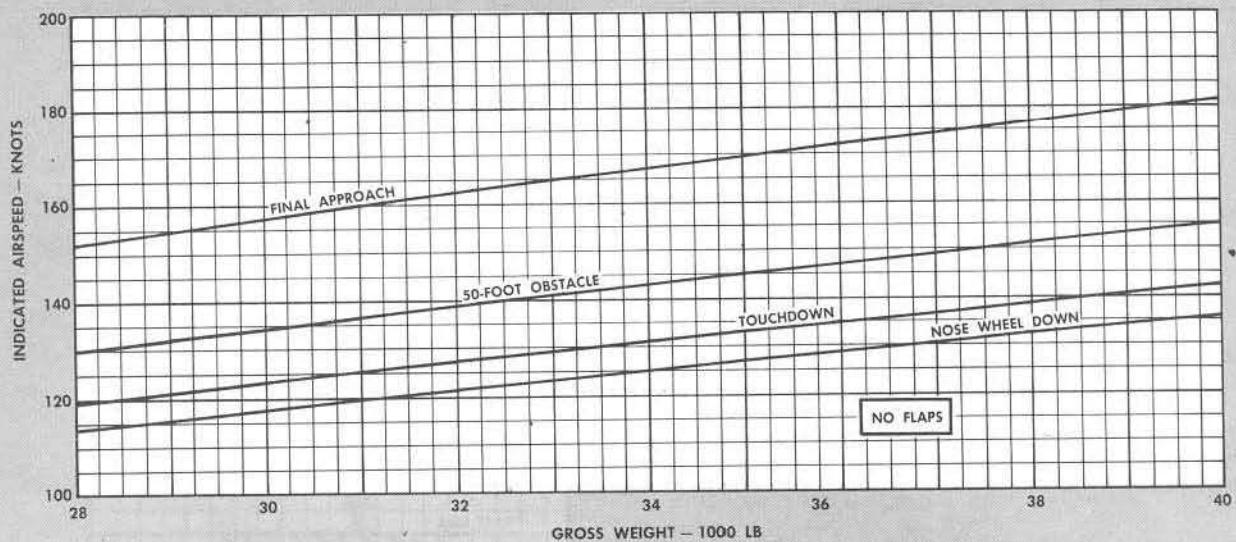
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL



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Figure A-25.

COMBAT ALLOWANCE CHART

MODEL: F-89D

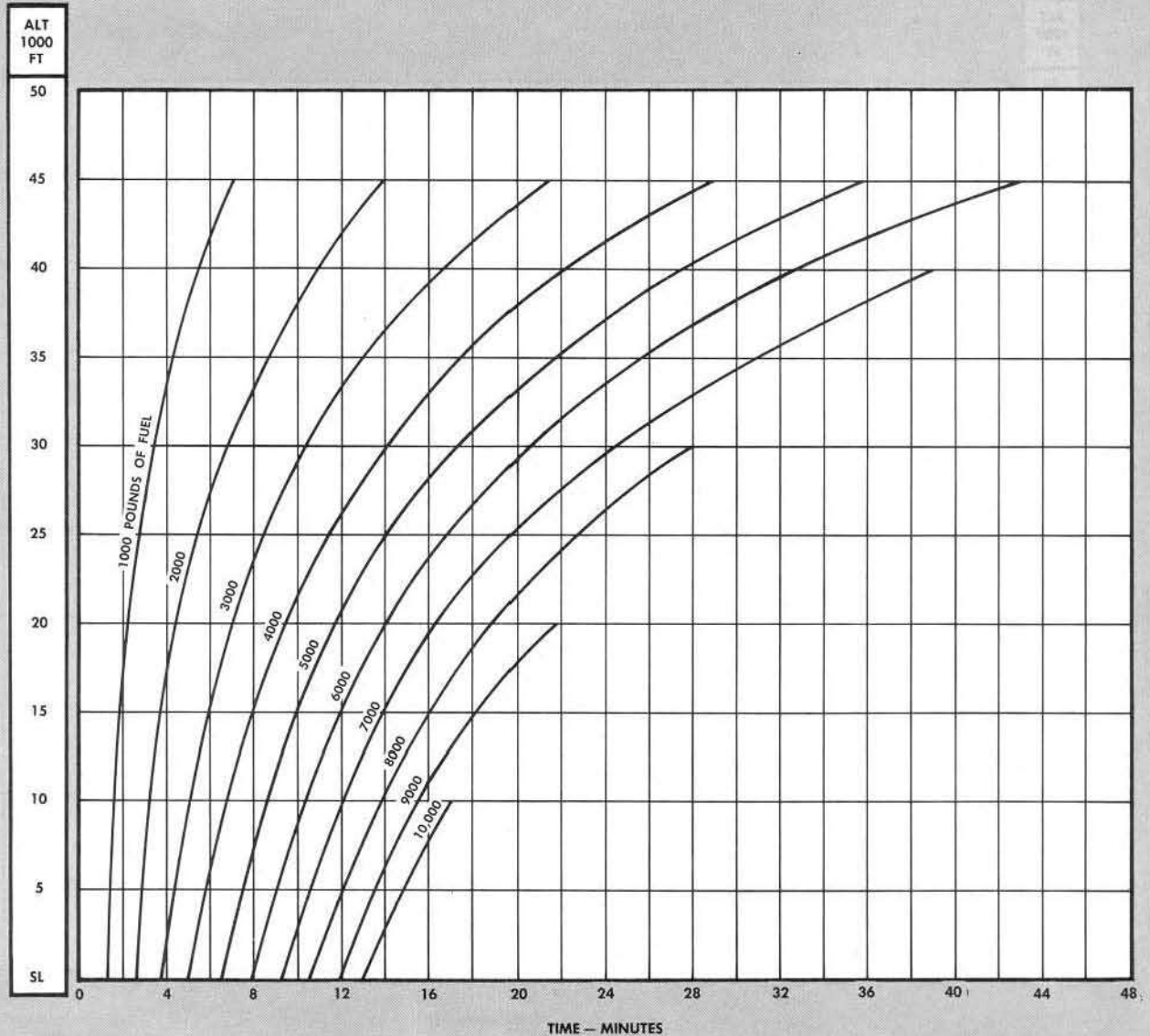
MAXIMUM POWER
NO EXTERNAL LOADJ35-35
OR
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. EXHAUST TEMPERATURE LIMIT: 750°C FOR J35-A-35, 735°C FOR J35-A-47.

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Figure A-26 (Sheet 1 of 3 Sheets).

COMBAT ALLOWANCE CHART

MODEL: F-89D

MILITARY POWER
NO EXTERNAL LOAD

DATA BASIS: FLIGHT TEST

DATE: 15 MARCH 56

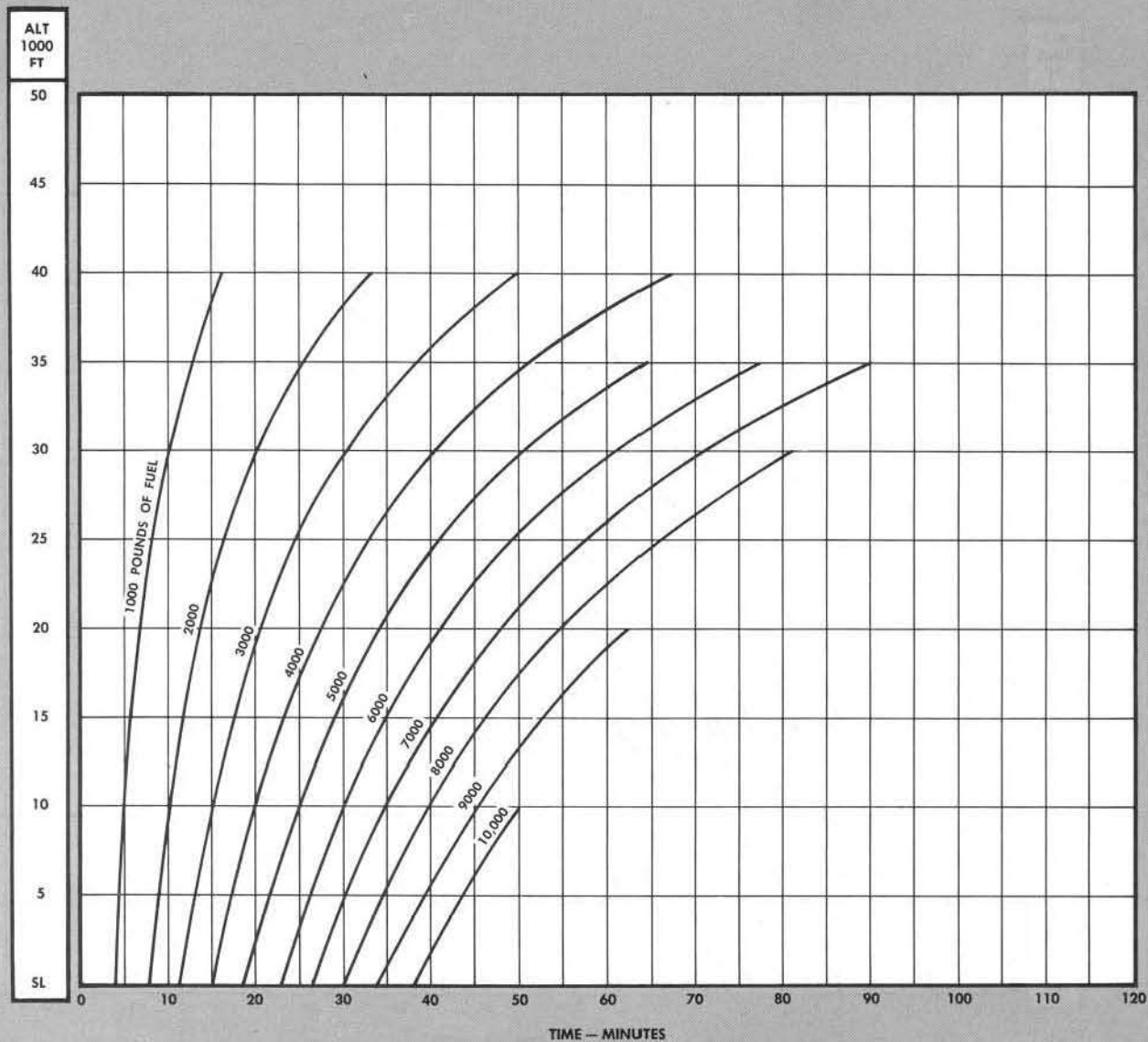
J35-35

OR

ENGINE(S): (2) J35-47

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. EXHAUST TEMPERATURE LIMIT: 750°C FOR J35-A-35, 735°C FOR J35-A-47.

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Figure A-26 (Sheet 2 of 3 Sheets).

COMBAT ALLOWANCE CHART

MODEL: F-89D

NORMAL POWER
NO EXTERNAL LOAD

J35-35

OR

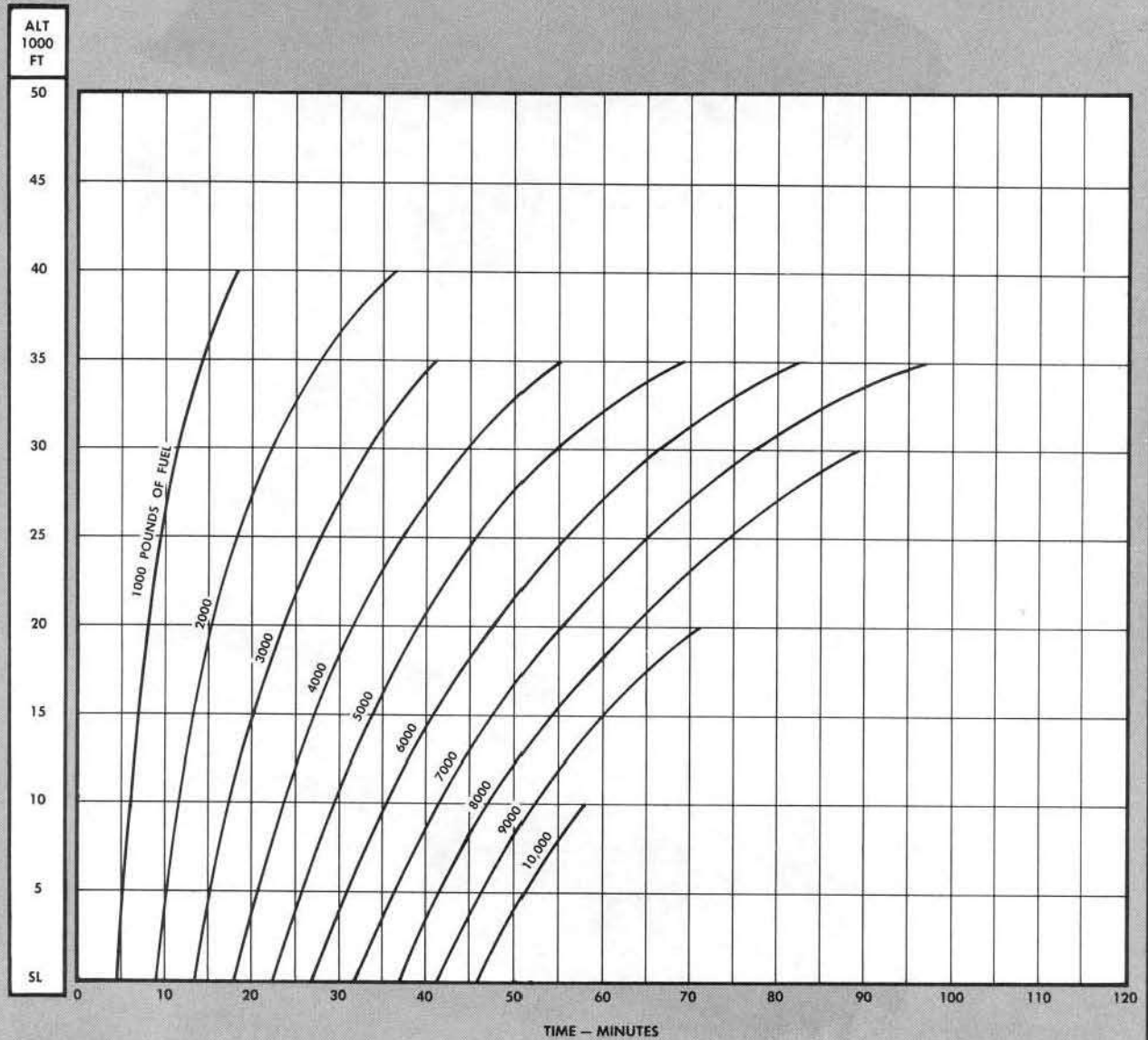
ENGINE(S): (2) J35-47

DATA BASIS: FLIGHT TEST

FUEL GRADE: JP-4

DATE: 15 MARCH 56

FUEL DENSITY: 6.5 LB/US GAL

**REMARKS:**

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. EXHAUST TEMPERATURE LIMIT: 680°C FOR J35-A-35, 666°C FOR J35-A-47.

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Figure A-26 (Sheet 3 of 3 Sheets).





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